nce Abstracts

Section A

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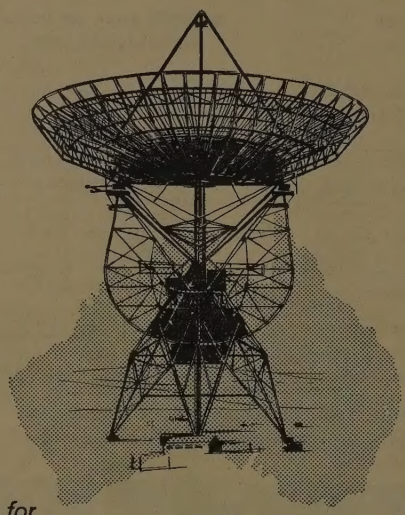

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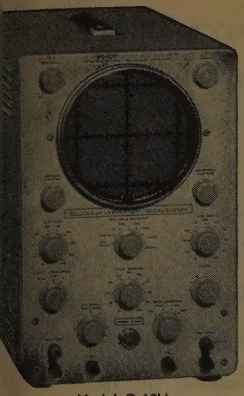

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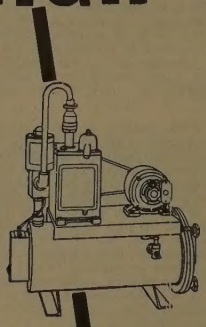

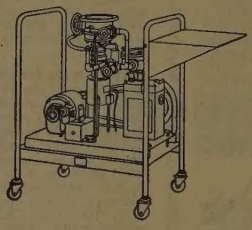

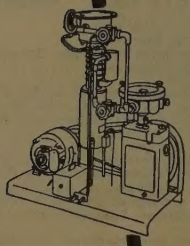

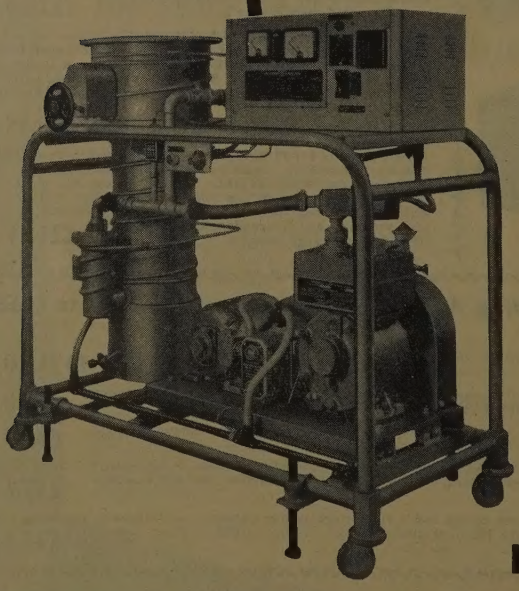

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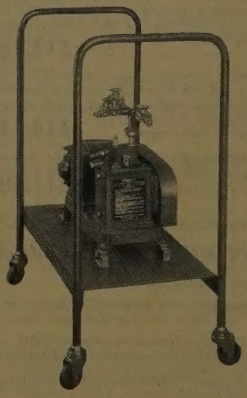

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PHYSICS ABSTRACTS

ume 64 DECEMBER 1961 (Part 1) Number 768 (Pt 1)

MATHEMATICS

5384 PRESSURE COMPENSATED FIELDS. R.Pratap.
strophys. (Germany), Vol. 52, No. 4, 272-8 (1961).
The differential equation for vector fields satisfying the relation the vector product of the vector with its curl gives the gradient scalar function of position has been solved in spherical coord-s. The results are applied to problems in hydrodynamics and omagnetics.

5385 CERTAIN PERIODIC SOLUTIONS OF NON-LINEAR DIFFERENTIAL EQUATIONS WITH PERIODIC FFICIENTS. R.Faure.
Acad. Sci. (France), Vol. 252, No. 24, 3727-9 (June 12, 1961).
rench.
The cases considered are second-order equations with a large meter, while the original system of equations (of the first r) contain both small and large parameters. The limits are ved for the existence of periodic solutions of $x = \mu f(x, x', t)$ as $\mu \to \infty$. J.K.Skwirzynski

5386 ON THE SOLUTION OF NONLINEAR EQUATIONS OF PHYSICAL FIELD THEORY. D.F.Kurdgelaidzé.
ers de Phys. (France), Vol. 15, 149-57 (April, 1961). In French.
Two examples of nonlinear equations are discussed, and shown ive solutions in terms of elliptic functions. The first example e equation of a nonlinear meson field, which reduces to that of nharmonic oscillator in one dimension; the second example is a al astrophysical problem having radial symmetry. The ciple of superposition of solutions of nonlinear equations is also ussed. J.W.Gardner

ASYMPTOTIC THEORY OF SYSTEMS OF ORDINARY FERENTIAL EQUATIONS WITH ALL SOLUTIONS NEARLY IODIC. See Abstr. 15722

AN APPROXIMATION TO THE REMAINDER OF ROBEY'S CTIVE IMPEDANCE INTEGRAL. See Abstr. 16025

A METHOD FOR CURVE-FITTING BY EXPONENTIAL CTIONS. See Abstr. 13669

5387 SOLID ANGLE CALCULATIONS. G.Rowlands.
rnat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 3 (April, 1961).
An analogy between the calculation of the total solid angle ended by an aperture at a point or extended source and the ulation of certain electrostatic forces and energies is discussed. shown that such solid angle calculations reduce to the uation of the electrostatic energies of uniformly charged sur-s. A collection of formulae for the calculation of the electro-ic energy of uniformly charged surfaces for a range of different es is given. The general method is illustrated by considering solid angle subtended by circular and rectangular apertures at t, surface and volume sources. In the case of rectangular tures and for a range of source distributions, the value of the solid e may be expressed analytically in closed form.

SOME DUAL SERIES EQUATIONS AND THEIR APPLICATION ELECTROSTATIC PROBLEMS. See Abstr. 16241

FUNCTIONS OCCURRING IN A STUDY OF DOMAIN CON-URATION IN THIN LAYERS OF $BaFe_{12}O_{19}$. See Abstr. 14714

15388 ON THE TIGHT PACKING OF EQUAL SPHERES AND ASSOCIATED PROBLEMS IN FLAT N-DIMENSIONAL SPACE. E.F.Fahy.
Amer. J. Phys., Vol. 29, No. 11, 725-8 (Nov., 1961).
Applies simple mathematics to the problem in N-dimensional geometry of packing equal spheres together. For the case of tight packing, it is found that the volume occupied per sphere is $R^N[(N+1)2^N]^{1/2}$, where R is the radius of the spheres. This is compared with the expression $[\pi^{1/2}NR^N]/[\Gamma(1+\frac{1}{2}N)]$ which is the volume of a single sphere. The relation of the tight packing, as defined above, to the closest possible packing is also discussed.

15389 SIMILARITY FUNCTION FOR PATTERN RECOGNITION. D.McLachlan, Jr.
J. appl. Phys. (USA), Vol. 32, No. 9, 1795-6 (Sept., 1961).
If we are given two plane "objects" described by some property ρ that varies with x and y, a function is obtained, after three transformations, that is claimed to be a maximum if the two objects are alike, that is if they are described by the same function ρ. The test is independent of the relative positions and orientations of the two objects, but would reckon two objects, one of which is a magnification of the other, as "different". The author considered that the transformations suggested are within the range of modern computers. H.N.V.Temperley

15390 DIGITIZER-TO-TAPE PUNCH-COUPLING UNIT. L.Molyneux, E.E.Schneider and G.R.Sharp.
J. sci. Instrum. (GB), Vol. 38, No. 10, 390-5 (Oct., 1961).
The unit briefly stores the output (twelve binary digits) from on optical or mechanical digitizer and produces signals which will cause a high-speed five-track tape punch to punch the stored information in four rows of holes. Three rows contain the twelve binary digits from the digitizer, while the fourth contains a marker hole and information set on four key switches. Except for the seven values necessary to drive the tape punch and digitizer light source, the unit uses transistors as its active circuit elements.

15391 DIGITAL MAGNETIC RECORDING SPEEDS NUCLEAR EXPERIMENTS. J.R.Waters and J.R.Bird.
Nucleonics (USA), Vol. 19, No, 3, 70-5 (March, 1961).
Binary words of 16 bits, each carrying coded information describing one event seen by the detectors, are recorded on 1 in. magnetic tape run at 1 or 2 in./sec. The recorded information is played back at 10-100 times the recording speed into a 1023 channel analyser. In order to avoid errors "1" is represented by a positive pulse and "0" by a negative one, and any word not giving a 16-fold coincidence is rejected. A de-randomizing unit, consisting of a small-capacity fast memory that accepts random information and passes it to the recorder at a regular rate, can be used to increase the rate at which pulses can be recorded. This together with an increase of tape speed to 15 in./sec enables a random rate of 2250 c/s to be accepted and 1.3×10^7 counts to be stored on a reel. The system was used for recording the time-of-flight of neutrons as they are detected by a number of counters, recording gamma-ray spectra after neutron capture as a function of neutron and γ-energy, and recording the results of three-dimensional pulse-height analysis. Improvements to the original apparatus are discussed and the system compared with others, including paper tape and punched card systems. R.D.Smith

RECOGNITION OF SPEECH BY A COMPUTER PROGRAMME. See Abstr. 15377

FUNCTION GENERATOR FOR ATOMIC SCATTERING FACTORS. See Abstr. 15065

15392 TIME DISTRIBUTION ANALYSIS RELATED TO STATISTICAL PHYSICS. A.de Moraes and P.A.Pompeia.
An Acad. Brasil. Cienc., Vol. 33, No. 1, 13-23 (1961).

Considers an experiment leading to two or more types of pulses, for instance, a cosmic-ray experiment where apart from true coincidences there may be other kinds of correlations between different groups of counters. A statistical method is developed for deciding whether or not the different kinds of pulses are correlated. This statistical method is applied to consider whether the decimal figures of e and of π are random number sequences. D.ter Haar

15393 INFORMATION AS A FUNDAMENTAL NOTION OF STATISTICAL PHYSICS. R.S.Ingarden and K.Urbanik.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 313-16 (1961).

It is suggested that for future progress in statistical physics it may be desirable to define probability distributions in terms of information, rather than the (orthodox) converse. A theorem which enables this to be done is stated here. The proof together with further mathematical discussion is to appear elsewhere.

R.O.Davies

15394 THE STATISTICAL PROPERTIES OF SEQUENCES OF STOCHASTIC PULSES. T.Lukes.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 153-68 (Aug., 1961).

A large number of physical phenomena may be represented as functions of space or time by a (usually infinite) sequence of irregular pulses. As examples we may take the emission of electrons from a cathode, or the process of conduction in metals or semiconductors. Two methods are presented for treating sequences of random pulses which are applicable to cases where the distribution of periods, durations or intervals is known. The methods are shown to lead to identical results and enable the correlation functions, after-effect functions and spectra to be calculated. The results are applied to typical sequences; some existing results are shown to be particular cases of the theory presented.

15395 ON THE THEORY OF AMPLITUDE DISTRIBUTIO IMPULSIVE RANDOM NOISE AND ITS APPLICAT TO THE ATMOSPHERIC NOISE. K.Furutsu and T.Ishida.
J. Radio Res. Lab. (Japan), Vol. 7, 279-307 (July, 1960).

Two phenomenological models are considered by which a impulsive random noises can be described: (I) Poisson Noise consisting of the superposition of independent, randomly occu elementary impulses. Much of noise in nature belongs to this (II) Poisson-Poisson Noise, consisting of the superposition of independent, randomly occurring Poisson noises, each Poisso noise forming a wave packet of some duration. The atmosphe noise is an example representative of this type. Because noi sources in nature are spatially distributed and the noise stre decreases with the distance, the amplitude of the received noi sometimes seriously depends on this spatial distribution of n sources. The amplitude probability distributions are conside according to the two typical cases of discrete and continuous distribution and are compared with those of actual atmospher good agreement. Moments of even order and correlations ar calculated for each model. Finally, the dependence of the use assumptions on the amplitude probability distribution are dis The obtained distributions in some cases are found to be inde of the used assumptions and thus quite general in a wide rang noise amplitude.

15396 SOLUTION OF STATISTICAL PROBLEMS OF PO ACCUMULATION BY ELECTRONIC ANALOGY.
G.Bizard and J.Seguinot.
Nuovo Cimento (Italy), Vol. 20, No. 5, 836-44 (June 1, 1961). In French.

This paper describes a method of electronic synthesis of probability density function of the random variable

$$\theta = x_1 + x_2 + \ldots + x_n$$

where the x's are mutually independent random variables each (known) probability density function p(x) and n is also a rando variable, independent of each individual x, and with a Poisson tribution with mean k. A flow chart ("bloc diagramme") for electronic circuit is shown in some detail. Numerical compar of experimental with theoretical results for the case p(x) = ex $(0 < x)$, and k = 9, are provided. N.J.J

ASTROPHYSICS

15397 MODERN ASTRONOMY.
G.Abetti.
Scientia (Italy), Vol. 96, No. 3, 71-6 (March, 1961). In Italian. French transl. in Supplement.

Elementary historical review of developments in the field of stellar magnetism and radioastronomy. R.A.Newing

15398 NOTES ON THE APPROXIMATIONS OF EDDINGTON.
S.Dumont.
C.R. Acad. Sci. (France), Vol. 252, No. 18, 2670-1 (May 3, 1961). In French.

Eddington's approximations are widely used, but have been shown to cause significant errors in certain cases. The error caused by these approximations in the source term for strong spectral lines is examined in this article, and it is shown that compared with source terms computed using an iterative technique the approximations can give results up to 16% too high.

H.Morrison

PLASMAS IN ASTROPHYSICS. See Abstr. 15726

TRANSITION PROBABILITIES AND OSCILLATOR STRENGTHS FOR ELEMENTS OF ASTROPHYSICAL INTEREST. See Abstr. 13917

15399 PROBLEMS IN FUTURE TELESCOPE DESIGN.
I.S.Bowen.
Publ. Astron. Soc. Pacific (USA), Vol. 73, 114-24 (April, 1961).

Future telescopes will be used chiefly with photoelectric devices rather than with direct-photography instrumentation. Careful consideration should therefore be given to the develop information on these devices in the design of any future major telescopes. Present predictions as to the properties of image intensifier tubes suggest that future telescopes should be desi with primaries of low focal ratio and with provision, at the pr or Newtonian focus, for image tubes and enlarging equipment handle plates of substantial size. They also point to a return optics for spectrographs and to the use of echelle gratings for higher dispersions. G.R.G

15400 A SOLAR FLARE PHOTOMETER USING A SAVAR POLARISCOPE. Y.Öhman and B.Ahnström-Sand
Ark. Astron. (Sweden), Vol. 40, Paper 2, 427-8 (1960).

A double image prism gives two slightly displaced image the sun. One of the images is made weaker than the other one that the faintest image of the flare shows zero polarization.

15401 A ½ A BIREFRINGENT FILTER FOR SOLAR RESE
W.H.Steel, R.N.Smartt and R.G.Giovanelli.
Austral. J. Phys., Vol. 14, No. 2, 201-11 (June, 1961).

A description is given of a wide-field birefringent filter h a bandwidth of ½ A at half-intensity, centred on Hα and tunable ±16 A. Constructional details are included.

STUDY OF THE 9 METRE SPECTROGRAPH OF THE PA MEUDON OBSERVATORY. See Abstr. 16080

5402 THE MAGNETOGRAPH OF THE FRAUNHOFER INSTITUTE.
Deubner, K.O.Kiepenheuer and R.Liedler.
strophys. (Germany), Vol. 52, No. 2, 118-31 (1961). In German.
A new magnetograph is described, the construction of which
ws in general the known models. Magnetic field and Doppler
of the Fraunhofer line λ5250.218 are recorded simultane-
y. The sensitivity obtained is 2 G and 50 m/sec, taking a
ning spot of 10 × 0.4 seconds of arc on the sun's disk and a
constant of 1 sec. The instrument was calibrated by using
Doppler shift of solar rotation. Some preliminary results are
ented.

5403 STANDARDIZATION OF THE LUMINESCENT SOURCE OF THE PARIS INSTITUT D'ASTROPHYSIQUE.
Mehltretter.
. Astrophys. (France), Vol. 24, No. 1, 40-4 (1961). In French.
Description of measurements of the energy distribution of the
dard luminescent source used at the Institut d'Astrophysique
aris to study continuous stellar spectra. Results of a compar-
with a black body. Supplementary investigations treating the
tancy of the source and the influence of its environment.

5404 THE DEGREE OF TWILIGHT IN WHICH PHOTOELECTRIC PHOTOMETRY IS POSSIBLE. J.D.Fernie.
thly Not. Astron. Soc. S.Africa, Vol. 20, No. 1-2, 13-14 (1961).
Using a conventional design of photoelectric photometer attached
e Cape of Good Hope 24 in. refractor, with medium/high-gain
lification, it was found that the level of zenithal sky-brightness
sufficiently low to allow of precise photoelectric measurements
g made when the true solar depression reached $13^{0}.5$. At
e Town, this corresponds to an interval of ~ 68 min before local
ise, or after local sunset. D.R.Barber

5405 A POSSIBLE TEST OF THE EXPANSION OF THE UNIVERSE FROM LUMINOSITY CURVES OF DISTANT ERNOVAE. A.Finzi.
. Astrophys. (France), Vol. 24, No. 1, 68-70 (1961).
The evolution of a receding supernova should appear slower to
arthly observer. The possibility to test in this way the expan-
of the universe is briefly discussed in this paper.

5406 THE THREE LAWS OF COSMOLOGY.
D.W.Sciama.
. Inst. Poincare (France), Vol. 17, No. 1, 13-24 (1961).
rench.
The three laws discussed are: (1) the universe as a whole
rts appreciable forces upon local matter, (2) local irreversible
cesses are related to the irreversible expansion of the universe
(3) the actual content of the universe is as significant as the
s which govern it. It is argued that local phenomena can be
d to derive information concerning the large scale properties
ne universe, and that fundamental characteristics of local
nomena can be explained in terms of such large-scale
perties. R.A.Newing

5407 OBSERVATION AND COSMOLOGY.
D.W.Sciama.
. Inst. Poincare (France), Vol. 17, No. 1, 25-36 (1961). In French.
A critical review of observations which could distinguish
veen steady state and evolutionary model universes includes
ussions of the relation between red-shift and apparent magni-
, the age distribution of galaxies, and also of the formation and
ribution of chemical elements and of galaxies on the two theories.
review concludes by noting possible future observations of
portance for cosmological theory. R.A.Newing

5408 THE STEADY UNIVERSE WITH CHARGE EXCESS.
L.G.Chambers.
ire (GB), Vol. 191, 262-3 (July 15, 1961).
Modified electromagnetic equations involving a "creation
ntial" are used to derive an expression for the rate of production
ydrogen atoms in agreement with the Lyttleton–Bondi theory.
suggested that the electrostatic repulsion between two hydrogen
ns must be greater than twice the gravitational attraction.
R.A.Newing

5409 THE ANALYSIS OF SPHERICALLY SYMMETRIC DISTRIBUTIONS OF MATTER. D.N.Limber.
rophys. J. (USA), Vol. 134, No. 2, 537-52 (Sept., 1961).
Methods are developed for analysing the spatial distributions and gravitational properties of distributions of matter that are spherically symmetric to at least a first approximation. It is shown how this can be conveniently done by resolving the actual spatial distribition into a superposition of polytropic distributions. In the second section a method is derived and the necessary tables are given for obtaining these polytropic components directly from strip-counts (or strip-masses) of the distribution projected on the plane of the sky. The third section presents a simple and direct method, together with the necessary tables, for obtaining the gravitational potential function for such distributions in terms of their polytropic components. Finally, it is shown how the results contained in a previous paper dealing with a method for applying the virial theorem in its usual form and in an extended form have a natural place among the types of analysis presented here.

15410 HOYLE'S COVARIANT FORMULATION OF THE LAW OF CREATION OF MATTER.
W.B.Bonnor and G.C.McVittie.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 5, 381-7 (1961).
Some solutions are obtained of the field equations recently proposed by Hoyle (Abstr.18599 of 1960) as a basis for the steady-state cosmology. In the cases studied it appears that Hoyle's theory is weaker than general relativity in that its solutions are more numerous. It is shown also that, for a model containing dust, prescription of both the metric and the density does not uniquely determine the motion of the matter present. Moreover, this motion does not necessarily follow geodesics of the space-time.

15411 THE OCCURRENCE OF CHEMICAL ELEMENTS IN THE UNIVERSE. H.Hubenet.
Ned. Tijdschrift. Natuurkde (Netherlands), Vol. 26, No. 5, 129-41 (May, 1960). In Dutch.
Surveys the present position, dealing respectively with the earth and meteorites, other planets, the atmosphere of the sun and stars, the internal constitution of the sun and stars, nebula and interstellar gas, cosmic rays, and isotopes. Figures are given for cosmic abundances and a list of empirical abundance rules is added.
J.Thewlis

15412 THE GENESIS OF THE ELEMENTS.
C.de Jager.
Ned. Tijdschr. Natuurkde (Netherlands), Vol. 26, No. 6, 157-74 (June, 1960). In Dutch.
Text of a lecture given to teachers. Starting from a discussion of the evolution of stars in the Hertzsprung–Russell diagram, a survey of nuclear reactions occurring inside the stars, and a survey of the abundance curve of the chemical elements, it is suggested that all elements have been constructed starting from a universe consisting of pure hydrogen, after which helium is formed in some stars and in others carbon, oxygen, etc.; neutron capture together with β-decay then leads to all elements up to bismuth, while supernovae provide the remaining elements and the high abundances in the neighbourhood of iron. D.ter Haar

ON THE GRAVITATIONAL INSTABILITY IN FLATTENED SYSTEMS WITH AXIAL SYMMETRY AND NON-UNIFORM ROTATION. See Abstr. 15598

15413 POSSIBLE METHODS FOR DETECTING INTERGALACTIC HYDROGEN. S.Hayakawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 5, 1131-2 (Nov., 1960).
It is suggested that radiation arising from transitions between S-states in recombination processes for hydrogen ions would include an observable continuous spectrum between Lα and the Balmer edge. R.A.Newing

15414 ON AMBIPOLAR DIFFUSION IN H I REGIONS.
D.E.Osterbrock.
Astrophys. J. (USA), Vol. 134, No. 1, 270-2 (July, 1961).
A calculation is made of the cross-section for collision between the neutral gas atoms and the positive ions in H I regions. The value obtained is very much larger than those previously estimated for use in connection with the heating of cool interstellar H I regions (Abstr. 989 of 1959) and contraction of interstellar cloud to a protostar with a magnetic field (Abstr. 5796 of 1957). The use of Osterbrock's value for cross-section decreases the heating of H I regions by magnetohydrodynamic dissipation and lengthens the time required for a cloud to contract in a magnetic field. S.P.Talwar

15415 INTERPLANETARY GAS. V. A HYDROGEN CLOUD OF TERRESTRIAL ORIGIN. J.C.Brandt.
Astrophys. J. (USA), Vol. 134, No. 2, 394-400 (Sept., 1961).

For Pt IV see Abstr. 5158 of 1961. Evidence is presented which indicates that the night-time Lyman-α observations can be attributed to solar radiation scattered by a cloud of hydrogen of terrestrial origin located at geocentric distances greater than about 5-10 earth radii. It also appears that the earth has a comet-like tail of hydrogen in the antisolar direction.

15416 AN ACCRETION HYPOTHESIS FOR THE ORIGIN OF THE SOLAR SYSTEM. R.A.Lyttleton.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 5, 399-407 (1961).

The possibility of direct accretion of interstellar matter by the sun is considered as a source of material for a solar disk as the initial stage of planet formation. The existing mass and angular momentum require a size and density of the cloud in close agreement with observed values. The range of action of the sun would require a relative speed of about 0·2 km/sec, and such a speed would have high probability of occurring at some time for any star over a period of several aeons. The amount of material falling directly into the sun would probably be so small as to bring negligible angular momentum to it. The hypothesis would allow an origin for the planetary material quite separate from the sun, and also would imply (assuming that a disk so formed would develop into planets) that a large proportion of old stars may have attendant planets. Besides resting on more secure hypotheses, a disk so formed would appear quite as suitable a source for planets as one relying on magnetic-coupling to the sun for its formation.

14417 THE RECORD IN THE METEORITES. VI. ON THE CHRONOLOGY OF THE EARLY SOLAR SYSTEM. G.G.Goles and E.Anders.
J. geophys. Res. (USA), Vol. 66, No. 3, 889-98 (March, 1961).

For previous work see Abstr. 2607 of 1961. An attempt is made to account for the differences between the isotopic composition of terrestrial and meteoritic xenon reported by Reynolds. The two chief mechanisms proposed (other than the decay of I^{129} to Xe^{129}) are the production of $Xe^{131-136}$ by spontaneous fission of extinct nuclides in the earth, and the production of $Xe^{124-128}$ by nuclear spallation reactions in the early history of the solar nebula. About 9.6% of the Xe^{136} in the earth's atmosphere appears to have arisen from the spontaneous fission of 76 million-year Pu^{244}, as proposed by Kuroda. The Pu^{244}–Xe^{136} decay interval of the earth is 290 Myr, and its I^{129}–Xe^{129} decay interval may be estimated as $\simeq$ 210 Myr. Thus, the earth appears to be 100-200 Myr younger than the meteorites. Possible errors in these determinations are discussed. A dating method, similar to the Pb^{207}–Pb^{206} method and based upon the two decay systems I^{129}–Xe^{129} and Pu^{244}–Xe^{136}, is proposed and the appropriate equations are given. The initial solar-system ratios of I^{129}/I^{127} and Pu^{244}/U^{238}, which can be determined by this method, would provide a crucial test of models of nucleosynthesis.

15418 THE FORMATION OF THE PLANETS OF THE SOLAR SYSTEM. N.P.Suworoff.
Naturwissenschaften (Germany), Vol. 48, No. 7, 214 (1961).
In German.

The variations in mass, angular momentum, gravitational and centrifugal acceleration during the evolution of the sun from spectral type gM to dM according to the author's theory are given in tabular form. It is supposed that the planets were formed during the transition from spectral type gF to dF, and the estimated ages of the various planets are given. R.A.Newing

15419 ON THE ORIGIN OF LUNAR RAYS. G.Fielder.
Astrophys. J. (USA), Vol. 134, No. 2, 425-34 (Sept., 1961).

Theoretical curves of the variation of intensity along a single ray were constructed and compared with the observational curves of Graff. The comparison lends support to the theory that ray-forming particles were mostly projected with velocities varying between the limits $0.7 \lesssim V \lesssim 1.5$ km sec^{-1}, and at elevations to the horizontal of $2^\circ \lesssim \theta \lesssim \Theta$, where Θ defines a "zone of avoidance", which, by analogy with explosion models, was possibly limited to $20^\circ \lesssim \Theta \lesssim 40^\circ$. Insufficient support can be found for Giamboni's theory that the "elliptical" ray which runs from Tycho toward Bullialdus was formed by particles shot into both low-angle and high-angle zones, the two sets of particles then being separated out in azimuth by the rotation of the moon. Objections to this th are listed. The present theory is consistent with independent evidence, obtained previously, which shows clearly that particle were ejected from ray craters mostly at fairly small angles to their tangent planes.

15420 ON THE FIGURE OF THE MOON. H.Jeffreys.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 5, 421-32 (1961).

A rediscussion of the librations of the moon's axis carried out literally to orders e^2 and i^2 of the main terms, and a sc effect not evaluated by Hayn (1902, 1923) is taken into account. It appears that solar effects nearly cancel the corrections for e^2 and i^2. The observational data are rediscussed and it appea that

$$\beta = 0{\cdot}000\,627\,9 \pm 0{\cdot}000\,001\,5$$

if the discrepancies between the observational determinations can legitimately be treated as random, but if this is not true th uncertainty may well be multiplied by 4. Recent discussions the annual libration in longitude appear to give values of γ nea to those given by the Yakovkin term. A method is proposed for dealing with the difficulty stated by Banachiewicz. The dat on the secular motions of the moon's node and perigee show n serious discrepancy with the results on its figure.

15421 ESCAPE OF GASES FROM THE MOON. E.J.Öpik and S.F.Singer.
J. geophys. Res. (USA), Vol. 65, No. 10, 3065-70 (Oct., 1960).

Contrary to expectations from the classical theory of an exosphere, it is found that even the heaviest gases, for exampl noble gases krypton and xenon, cannot be retained by the moon Because of the ionizing effects of solar ultraviolet radiation, electric forces now become more important than gravitational forces. First thermal escape from a thick atmosphere with a top is considered and then from a thin atmosphere accommoda to the temperature of the surface, but still not an exosphere. rate of escape of photoelectrons is also calculated and the esc rate of ions is deduced. The lifetime of an atmosphere contain all the krypton and xenon believed to have evolved since the or of the moon is of the order of 800 and 50 yr respectively. Afte the atmosphere has thinned to less than a mean-free path (i.e. exosphere), yet another mechanism of escape of heavy gases e It seems likely that the moon as a whole is positively charged potential of about +20 volts, owing to the great intensity of sola ultraviolet radiation. Hence, in the vicinity of the moon there exist a strong electrostatic field. Whenever a krypton or xeno is ionized while it is in flight within the screening length near moon, the ion will be expelled by the electrostatic field. The lifet turns out to be ~1000 yr and is somewhat increased by the eff solar corpuscular streams. Hence it is concluded that there i much likelihood that light or heavy gases evolving from the mo will be retained by the moon. The only gas in the vicinity of th moon can come from interplanetary space itself.

15422 A LUNAR SEISMIC EXPERIMENT. F.Press, P.Buwalda and M.Neugebauer.
J. geophys. Res. (USA), Vol. 65, No. 10, 3097-105 (Oct., 1960).

A feasibility study shows that a lunar seismic experiment provide significant data on the structure and composition of th moon. The presence or absence of lunar seismicity is an imp clue to current tectonic processes that affect the lunar surface the first generation of experiments, single detectors are envis with the capability of recording body and surface waves. Inves tion of proposed methods of lunar-seismogram interpretations cates that these detectors should be sufficient to give a rough outline of lunar seismic geography and to indicate crudely the composition of the moon as well as its main structural feature the absence of lunar seismicity, the best statistics on the freq of meteorite impacts indicate that meteorites may provide use auxiliary seismic sources. In reaching this conclusion, reaso estimates were made of the efficiency of impact as well as of seismic-wave attenuation. Critical factors in the experiment instrument lifetime and sensitivity and the nature of lunar mic seismic noise.

5423 THERMAL RADIATION FROM THE MOON AND THE HEAT FLOW THROUGH THE LUNAR SURFACE.
Baldwin.
thly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 513-22 (1961).
Observations of thermal radiation from the moon at a frequency 78 Mc/s are described, giving a value for the mean disk temperature of 233 ± 8°K, which is the same to within 25°K as various mates of the mean disk temperature at the surface. The absence of any detectable steady temperature gradient through the surleads to upper limits on the steady heat flow from the moon for a ge of possible properties of the surface materials. The observas at shorter radio wavelengths favour a model in which a gravelly erial extends to depths of at least several metres. For this el the upper limit to the heat flow is very close to that expected n radioactive decay in a moon of chondritic composition.

15424 ON THERMODYNAMICS OF PLANETS. C.Lomnitz.
phys. J. (GB), Vol. 5, No. 2, 157-161 (July, 1961).
A thermodynamical theory of planets is outlined. General lts by Prigogine, de Groot and others are applied to the case steady-state system with a constant temperature distribution. 'excited state" is defined by pressure perturbation introduced n earthquake at the surface of the planet. The resulting sient flows towards the perturbed region are analysed, and it hown that the energy transient is logarithmic in time. A con- on of realizability of the earthquake problem is defined. For a en planet type there is a critical size below which no seismic vity can occur on the planet.

15425 ON CARBON DIOXIDE IN THE ATMOSPHERE OF VENUS. V.A.Firsoff.
ervatory (GB), Vol. 81, 62-4 (April, 1961).
Assuming that the Cytherean clouds have a substantially restrial composition a mean ground temperature of Venus of .5°C can be obtained. However, this assumption does not take account the excessive amount of CO_2 in the Cytherean stratoere, and the author considers whether this could be due to the ater proximity of Venus to the Sun. Assuming that at least the er layers of the troposphere are colder than the air above the ds, and approaching the problem differentially it is found that molecules tend to diffuse upwards more rapidly than other ecules. The temperature of the upper atmosphere rises with inasing CO_2 concentration, eventually convection supervenes and overheated gas is carried to still higher levels. In this way, a ge excess of CO_2 would be built up in the Cytherean stratosphere r geological time. G.R.Greatrix

5426 MAGNETIC FIELD OF THE PLANET VENUS. J.V.Narayana.
iakanal Obs. Bull. (India), No. 153, 163-70 (Aug. 4, 1959).
Statistical plots of daily equivalent planetary amplitude Ap, ilar to the magnetic character figure Ci, for 50 days before and days after every inferior conjunction of Venus during the years of sunspot activity over the period 1884-1955, show that there is a rked decrease in the value of geomagnetic activity about 2 days re the date of conjunction. This asymmetry of the decrease nd the date of conjunction suggests a deflection of solar puscles by Venus, thereby indicating the presence of some magc field surrounding the planet. Assuming, according to Störmer, equatorial ring current of about 10^6 km radius around the earth, value of the polar magnetic field of Venus works out to about G. Alternatively, if a ring current of about 10 earth radii is med, then according to Martyn (1951), the polar magnetic field enus becomes 0.024 G. The above values have been used for puting the rotation period of Venus, assuming that Blackett's irical formula (1947) is applicable to this case. The rotation ods thus obtained are 2 days and 24 days respectively. These es are in better agreement with the faster rotation with a period few days estimated by some astronomers than with the much er rotation with a period of 225 days obtained by others. Similar lyses in the cases of Mercury and the moon give no sure indication he existence of magnetic fields on these bodies.

15427 OPPOSITIONS OF MARS IN 1954 AND 1956. A.K.Das.
iakanal Obs. Bull. (India), No. 154, 171-201 (Aug. 31, 1959).

15428 THE ATMOSPHERE AND HAZE OF MARS. E.J.Öpik.
J. geophys. Res. (USA), Vol. 65, No. 10, 3057-64 (Oct., 1960).
The "blue haze" is an absorbing smoke, dark as soot in reflection, red in transmission. Its currently accepted explanation by pure scattering (omnidirectional or forward) is untenable, as it would either increase the surface brightness or fail to obscure the surface details. The limb darkening of Mars is mainly the result of absorption by the smoke. The opacity of the Martian atmosphere increases from the red toward the violet. The extinction by the Martian atmosphere is greater than that by the terrestrial at all wavelengths, but only about 20% of the Martian extinction is due to scattering. Dollfus, polarimetric estimate [Publ. Astron. Soc. Pacific (USA), Vol. 70, 56-64 (1958)], corrected for self-absorption, corresponds to a Martian atmospheric pressure of 87 mm Hg. The photochemical breakup of carbon dioxide and the escape of oxygen must lead to considerable concentrations of carbon monoxide in the Martian atmosphere.

15429 AN EXPERIMENT WITH A LYOT HELIOGRAPH AT A TRANSIT OF MERCURY. D.S.Evans.
Monthly Not. Astron. Soc. S.Africa, Vol. 20, No. 3, 26-9 (1961).
The automatic Lyot heliograph installed at the Cape of Good Hope Observatory (Abstr. 3028 of 1959) was used experimentally to record the transit of Mercury across the solar disk on 7 November 1960. Positions of the planet on the solar image (~ 15 mm diameter), obtained from 21 frames exposed at intervals of from 15 to 60 seconds, are tabulated. The various errors involved in calculating the angular movement of the centre of Mercury are discussed, and the overall accuracy of the method is assessed. D.R.Barber

15430 ORIGIN OF JUPITER'S GREAT RED SPOT. R.Hide.
Nature (GB), Vol. 190, 895-6 (June 3, 1961).
To account for the main features of the Jovian Red Spot a model is suggested in which the spot is represented by a shallow topographical feature of the solid planetary surface. Hydrodynamical considerations indicate that, on account of the planet's rapid rotation, atmospheric turbulence above the surface feature will still be manifest in the cloud-layer at the top of the Jovian atmosphere. Turbulence will be more intense on the pole-ward side of the spot, and may account for the radio-noise bursts emanating from this region. D.R.Barber

15431 DENSITY OF C_2 MOLECULES IN THE HEAD OF THE COMET MRKOŠ 1955e. L.Houziaux.
Ann. Astrophys. (France), Vol. 23, No. 6, 1025-31 (1960).
In French.
The energy emitted in the 1-0 band of the Swan system of C_2 is derived from photoelectric observations. The intensity distribution as a function of the distance from the nucleus is used to determine the mean densities of C_2 molecules for various diameters of the head. These densities vary from 2828 to 67 molecules cm^{-3} from regions close to the nucleus to regions located at one minute angular distance from the nucleus.

15432 RELATIONS BETWEEN PLASMA PHYSICS AND ASTROPHYSICS. COMMENT ABOUT COMET TAILS. W.F.Huebner.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 498 (July, 1961).
Reference is made to a paper by Alfven (Abstr. 5447 of 1961) and to one by Biermann (Abstr. 5150 of 1961) concerning the mechanism for the origin of comet tails. The process of charge exchange, proposed by Biermann to account for the ionization of CO and N_2 in the heads of comets, is criticized on the grounds that it does not account for the initial velocities of the ions, of 10 to 30 km/sec, at the origin of the tail streamers. Also, charge exchange cross-section calculations indicate that the process is unlikely. A mechanism is suggested involving the interaction of the neutral molecules of the gas jets coming away from a comet with the magnetized interplanetary plasma. M.Kasha

15433 THE RADIANT AND ORBIT OF A BRIGHT FIREBALL. B.A.Lindblad.
Ark. Astron. (Sweden), Vol. 46, Paper 2, 495-516 (1960).
The atmospheric path of a bright fireball which appeared over Scandinavia on January 9, 1954, is calculated (i) from visual data (ii) from early photographs of the persistent train. The results are compared and conclusions are drawn regarding the orbit in space.

15434 ANOMALIES IN THE LIGHT CURVES OF METEORS RESULTING FROM FRAGMENTATION.
R.Ananthakrishnan.
Nature (GB), Vol. 190, 896-7 (June 3, 1961).

The theoretical curve of stellar magnitude versus altitude is very skew. The author's modification is also skew but the rise to and decay from maximum luminosity takes place over a smaller altitude range. If those observations of Hawkins and Southworth [Smithsonian Contrib. Astrophys. (USA), Vol. 2, 349 (1958)] and of Whipple [Abstr.1241 of 1944; Advances in Geophysics (USA), Vol. 1, 135 (1952); and Astron. J. (USA), Vol. 59, 246 (1954)] are rejected, as pertaining to fragmenting meteors, which do not show a sufficiently skew character, the remainder are shown to fit the author's modified theory better than the original theory. If observations on the Draconids of October 1946, which were a very clear indication of the existence of fragmenting meteors, are plotted on a similar diagram, there is almost no skewness in the resulting distribution. D.M.Gilbey

15435 THE DISTRIBUTION OF COSMIC-RAY-PRODUCED RARE GASES IN IRON METEORITES.
P.Signer and A.O.Nier.
J. geophys. Res. (USA), Vol. 65, No. 9, 2947-64 (Sept., 1960).

The cosmogenic A^{38}, A^{36}, Ne^{22}, Ne^{21}, Ne^{20}, He^4, and He^3 distribution in part of a cross-section of the iron meteorite Grant was measured. The amounts were found to vary systematically with depth. The depth effect was analysed in terms of a production mechanism, and numerical parameters were determined. Comparisons were made with the results of other investigations. Functional relationships correlating relative amounts of cosmogenic nuclides with position and size of a meteoritic body are demonstrated. In principle the determination of a sufficient number of cosmogenic nuclides in a single sample permits deductions about the radiation dosage and the size of the meteoroid as well as the location of the sample within the body.

15436 METEORITES AS SPACE PROBES FOR TESTING THE SPATIAL CONSTANCY OF COSMIC RADIATION.
R.W.Stoenner, O.A.Schaeffer and R.Davis, Jr.
J. geophys. Res. (USA), Vol. 65, No. 10, 3025-34 (Oct., 1960).

An experiment was performed to test the spatial constancy of cosmic radiation within the solar system by measuring a short-lived and long-lived cosmic-ray-induced radioactivity in a recently fallen stone meteorite. The measurement was performed on the Hamlet chondrite that fell in Indiana on October 13, 1959. The ratio of the 35-day A^{37} to the 325-year A^{39} was found to be 2.0 ± 0.3. The relative production rates for these isotopes was determined by bombarding the meteorite with 3 BeV protons. The ratio of the A^{37} to A^{39} production rates was found to be 1.5 ± 0.2. Since the ratios were the same within experimental uncertainty, it was concluded that the flux of cosmic radiation is constant in the space between the earth and the asteroidal belt. The A^{39} contents of four other chondrites were measured. The values obtained were as follows: Richardton 7.1 ± 0.6, Murray 9.4 ± 0.5, Forest City 11.9 ± 0.5, Benton 9.0 ± 0.4, and Hamlet 7.8 ± 0.2 dis/min kg.

"SPATIAL CONSTANCY OF COSMIC RADIATION USING METEORITES AS SPACE PROBES". See Abstr.

15437 ARGON 37, ARGON 39, AND TRITIUM IN METEORITES AND THE SPATIAL CONSTANCY OF COSMIC RAYS.
E.L.Fireman and J.DeFelice.
J. geophys. Res. (USA), Vol. 65, No. 10, 3035-41 (Oct., 1960).

The radioactive isotopes A^{37}, A^{39}, and tritium were measured in the Hamlet chondritic meteorite and in the Aroos iron meteorite. The ratio of the radioactivity of A^{37} to that of A^{39} at the time of fall was 2.3 ± 0.2 for the Hamlet meteorite and 1.4 ± 0.3 for the Aroos meteorite. The ratio of the production rate of A^{37} to that of A^{39} in a sample of the Hamlet meteorite irradiated with 2-beV protons was 1.2 ± 0.3. These measurements indicate a higher flux of cosmic rays at a distance of 1 astronomical unit from the sun than at several astronomical units. The ratio of the radioactivity of tritium to that of A^{39} was 29 ± 6 for the Hamlet meteorite and 2.0 ± 0.5 for the Aroos meteorite. The ratio of the production rates in the Hamlet target sample was 24 ± 6. The ratio of tritium to A^{39} in the Benton chondritic meteorite was 29 ± 4. The data indicate that the cosmic-ray flux integrated over the same region of space for different times is constant. The tritium is anomalously low in the Aroos iron meteorite. Similar tritium anomalies were observed previously in iron meteorites.

15438 SEARCH FOR EXTINCT LEAD 205 IN METEORITE
E.Anders and C.M.Stevens.
J. geophys. Res. (USA), Vol. 65, No. 10, 3043-7 (Oct., 1960).

The isotopic composition of thallium from six meteorites was measured, in order to determine whether any radiogenic Tl^{205} from the decay of 24-m.y. Pb^{205} was present. Although the Pb:Tl ratios of these meteorites differed by factors of 50, isotopic composition of meteoritic and terrestrial thallium were equal to within 1%. For Canyon Diablo, this implies a solidification time of $\geq 3.0 \times$ years after nucleogenesis by the "sudden synthesis" model, and $\geq 1.0 \times 10^8$ years after the isolation of the solar system by the "continuous synthesis" model. The bearing of these results on I^{129}-Xe^{129} ages of Reynolds (Abstr. 12272 of 1960) is discussed.

15439 THE ORIGIN OF METEORITES.
B.Mason.
J. geophys. Res. (USA), Vol. 65, No. 9, 2965-70 (Sept., 1960).

Current hypotheses generally interpret chondritic meteorites as being debris from a disrupted planet. It is suggested that the meteorites are not fragments of such a body, but have always been independent and individual objects. They can have been produced by the recrystallization of material now represented by the carbonaceous chondrites. The composition of carbonaceous chondrites is such that if they are heated above 600°C they would give a mixture of olivine, orthopyroxene, and nickel–iron similar to that of the chondritic meteorites. The friable and porous nature and the chondritic structure of these objects suggest recrystallization essentially in the solid state, as does the intimate admixture of nickel–iron and silicate. The other types of meteorites — achondrites, pallasites, and siderites — can be explained as fragments of a differentiated planetoid or planetoids formed by the aggregation of chondrites.

15440 IODINE CONTENT OF METEORITES AND THEIR I^{129}–Xe^{129} AGES. G.G.Goles and E.Anders.
J. geophys. Res. (USA), Vol. 65, No. 12, 4181-4 (Dec., 1960).

Iodine and tellurium abundances in chondritic meteorites were determined by neutron activation analysis. For bronzite and hypersthene chondrites (6 analyses) iodine abundances from 37 to 104 ppb were found; for enstatite and carbonaceous chondrites (9 analyses), the range is from 127 to 560 ppb. The tellurium abundances range from 0.42 to 0.73 ppm and 1.23 to 3.4 ppm respectively. I^{129}–Xe^{129} decay intervals, measured from the cessation of nucleosynthesis, were calculated for the meteorites Richardton (119^{+9}_{-6} m.y.) and Indarch (97^{+17}_{-10} m.y.), using the continuous nucleosynthesis model. The significance of these results is discussed.

15441 NANOMETEORITES.
C.L.Hemenway, E.F.Fullam and L.Phillips.
Nature (GB), Vol. 190, 897-8 (June 3, 1961).

Evidence for the existence of "nanometeorites" of about 75 diameter is adduced from the electron-microscope examination of impact-type collectors after flight at 60 000 ft over the Arctic on 15th Nov. 1960 in a period of unusual solar activity. D.M.

15442 SOLAR RESEARCH FROM ROCKETS.
R.Tousey.
Science (USA), Vol. 134, 441-8 (Aug. 18, 1961).

Review article on the new prospects offered by the greatly broadened spectrum above the atmosphere.

15443 SOLAR SEEING.
R.G.Giovanelli.
Nature (GB), Vol. 190, 771-2 (May 27, 1961).

Since all ground-based observations of solar phenomena have perforce to be made through the earth's atmosphere, it is of the utmost importance that full attention should be given to quantity measurements of "daytime seeing". Daytime conditions at various observatories in Europe and America are briefly described, and discussed in relation to relevant meteorological factors. In general, the presence of an anticyclonic circulation over the observing site is found to be beneficial, since there is then little convection. The problem of instrumental "seeing" may be solved by a suitable choice of optical and mechanical design, thereby minimizing local heating effects. Finally, by taking the utmost advantage of the inevitably brief periods of excellent "seeing" with the aid of an automatic photoelectric monitor combined with an electronic camera, optimum resolving power may be achieved. D.R.B.

OLAR PHENOMENA JULY 10-19, 1959.
.bstr. 15251

OLAR PHENOMENA MARCH 29-APRIL 5, 1960.
bstr. 15252

5444 SOUND WAVES TRAPPED IN THE SOLAR ATMOSPHERE. F.D.Kahn.
phys. J. (USA), Vol. 134, No. 2, 343-6 (Sept., 1961).
Sound waves can be trapped in the solar atmosphere, and the
rn they make tends to repeat itself at intervals of about 5 min,
distortions of about 2250 km. This may lead to a 5 min
dicity in the appearance of the fine structure of the sun.

5445 ON THE RELATIVISTIC ELECTRONS IN THE SOLAR ATMOSPHERE. K.Sakurai.
omagn. Geoelect. (Japan), Vol. 12, No. 2, 70-6 (1961).
Considers the various processes of the ejection of relativistic
rons in association with flares and examines how these
rons lose their energies. It can be shown that these electrons
e trapped in the sunspot magnetic fields (~ 100 gauss) and
lose the majority of their energies through synchrotron radia-
Radio waves emitted by these synchrotron radiation processes
e observed as the type IV outbursts.

5446 ON THE INTERPRETATION OF THE FRAUNHOFER LINE NaD_1. Y.Tomita.
. Astron. Soc. Japan, Vol. 12, No. 4, 524-51 (1960).
Describes in detail the assumptions, methods and inter-
ation of calculations made on the centre—limb variation of the
ile of this line, using two alternative photosphere models
tr. 8008 of 1954) and assuming both coherent and incoherent
tering processes. Agreement with experiment is not good for
of the four calculated cases, and possible variations to improve
are discussed. J.Hawgood

5447 STUDY OF THE CONTINUOUS SOLAR SPECTRUM: SYSTEMATIC INVESTIGATION OF DEVIATIONS
M LOCAL THERMODYNAMIC EQUILIBRIUM. Y.Cuny.
. Acad. Sci. (France), Vol. 252, No. 26, 4111-13 (June 26, 1961).
rench.

5448 STUDY OF THE CONTINUOUS BACKGROUND OF THE SOLAR SPECTRUM. V. THE STANDARD BLACK
Y. R.Peyturaux.
. Astrophys. (France), Vol. 24, No. 3, 258-60 (1961). In French.
For Pt IV, see Abstr. 5838 of 1955. Description of a black
operating in vacuum at 2600°K and designed to obtain an
lute measurement of the sun's monochromatic radiation.

5449 THE DEPTH OF FORMATION OF THE LINDHOLM EFFECT. M.Jorand.
. Acad. Sci. (France), Vol. 252, No. 24, 3739-41 (June 12, 1961).
rench.
According to Lindholm (1941), an empirical relationship,
$= 0.36\gamma$, exists between the frequency shift of the displaced
r line, $\delta\nu_L$, and the collisional damping factor, γ. However,
evaluation of the collisional parameter by the aid of curves of
vth for a number of selected solar lines is not sufficiently
ise to yield an accurate value of the Lindholm displacement.
s previous measures of the latter making use of the above
ation (Adam, 1948) are suspect. A re-determination of $\delta\nu_L$ for
solar atmosphere is based on an application of the radiative
sfer problem. It leads to a smaller value than those previously
ined, 0.0015 A as against Miss Adam's value of 0.0041 A.
culation also shows that the Lindholm effect originates at an
cal depth, $\tau_L = 0.037$, below the photospheric surface.
D.R.Barber

5450 THE INHOMOGENEITY OF THE SOLAR PHOTOSPHERE. R.Michard.
. Acad. Sci. (France), Vol. 252, No. 26, 4120-2 (June 26, 1961).
rench.
Describes the results of an analysis of high-quality
unhofer spectra obtained at Sacramento Peak Observatory,
A, with a Littrow spectrograph (F = 13 m; δl_λ = 12.8 mm/A,
5173 A). Local fluctuations of brightness in the cores of
unhofer lines of average-to-high mean intensities possess
racteristics that appear to be incompatible with those based
accepted non-homogeneous solar models. D.R.Barber

15451 DEVIATION FROM EQUILIBRIUM AND ABUNDANCES IN SOLAR AND STELLAR PHOTOSPHERES. IV. THE CASE OF IONIZED TITANIUM. J.C.Rountree.
Ann. Astrophys. (France), Vol. 23, No. 6, 1010-24 (1960).
In French.
For Pt I-III, see Abstr. 14414-16 of 1960.

15452 DEVIATION FROM EQUILIBRIUM AND ABUNDANCES IN SOLAR AND STELLAR PHOTOSPHERES. V. THE ABUNDANCE OF TITANIUM. R.Kandel.
Ann. Astrophys. (France), Vol. 23, No. 6, 995-1005 (1960).
In French.
In a study limited to the first multiplet of Ti I, the abundance the departures from LTE were determined with a higher order of accuracy. Log A = $\bar{4}.15$.

15453 DEVIATION FROM EQUILIBRIUM AND ABUNDANCES IN SOLAR AND STELLAR PHOTOSPHERES. VI. THE VARIATION OF CENTRAL INTENSITIES OF METALLIC LINES BETWEEN THE CENTRE AND THE LIMB OF THE SUN. J.Lefevre and J.C.Pecker.
Ann. Astrophys. (France), Vol. 24, No. 3, 238-50 (1961). In French.
The study of the centre—limb variation of central intensities of some titanium lines yields relations for $T_{exc}(\tau)$ which do not coincide with those obtained by consideration of centre-of-the disk measurements only: this is the "fishbone effect". In the general frame of 3-temperature models of the photosphere, this can be interpreted by the consideration of the "roughness effect"; hot regions being, at the line centre, less opaque than cold regions which mask them at the solar limb. The fishbone effect allows the fixing of the size of inhomogeneities at 300 km in the case of Bohm's model. Moreover, the existence of inhomogeneities does not affect deeply the departures from LTE.

15454 A STUDY OF THE PHOTOSPHERE AND SUNSPOTS USING MOLECULAR BAND [SPECTRA]. G.Laborde.
Ann. Astrophys. (France), Vol. 24, No. 2, 89-138 (1961). In French.
Rotational temperatures are derived for spot and photospheric regions of the solar disc using band spectra of MgH, C_2, CH, CN, NH and OH. The bands of MgH, consisting of weak lines, are best suited to this method of assessing temperatures: they yield concordant results from two different sunspot regions. In addition, the pressures corresponding to the levels at which the molecular sunspot lines originate have been evaluated from the C_2 bands. These values are found to be independent of the temperature of the spot, although they are sensitive to the choice of model adopted for their evaluation. Preference is given to the photospheric model of Minnaert (1949) as amplified by Athay, Menzel, Pecker and Thomas (1955, 1957). D.R.Barber

15455 AN ESTIMATE OF THE PEAK SUNSPOT NUMBER IN 1968. C.M.Minnis.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 94-9 (March, 1961).
An examination has been made of some statistical properties of the twenty peaks in the relative sunspot number which have occurred since 1750. The frequency distributions of R and ΔR and the autocorrelation function have made it possible to forecast the magnitude of the next peak which will probably occur in about 1968. It is concluded that there is a probability of at least 0·75 that this peak will lie in the range 110-160.

15456 INCLINED LINES OF SUNSPOT ACTIVITY. R.A.Miller.
Observatory (GB), Vol. 81, 95-8 (June, 1961).
K-line spectroheliograms often suggest that zones of sunspot activity are inclined to the solar equator. This suggestion is examined by carrying out a statistical analysis of 803 spots, weighted according to their area in square degrees, no spot having a weight of less than one. Ninety-five per cent of the spots occurring in six regions are used in calculating 19 regression lines which are highly significant and demonstrate the reality of slanted lines of sunspot activity for these regions. The locations of 172 arch-type prominences are also examined: 84% of these are found to lie wholly outside of the calcium faculae. Several of the roots of these prominences are located at the regression lines determined by the positions of the sunspots. It is concluded that, near sunspot maximum, there may exist slanted lines of activity possibly arising from extensive tubes of flux beneath the solar surface. G.R.Greatrix

15457 MODELS OF SUNSPOTS AND PROTUBERANCES ON SPOT EDGES. E.Schatzman.

Ann. Astrophys. (France), Vol. 24, No. 3, 251-7 (1961). In French.

A force-free magnetic field with axial symmetry leads to a satisfactory sunspot model. Fitting an interior solution to an outer solution, with a discontinuity of the vertical component of the magnetic field, one obtains (like Schlüter and Kippenhahn) a vertical force which can bear a thin layer of matter. This layer is cylindrical and it can explain the spot prominences. The stability of these layers is discussed.

15458 NOTE ON THE EVERSHED EFFECT IN SUNSPOTS. P.Maltby.

Ann. Astrophys. (France), Vol. 23, No. 6, 983-5 (1960).

At the Solar Observatory of Harestua observations were made to investigate the Evershed effect in sunspots. A preliminary reduction of the measurements points to a close connection between the intensity of the umbra and the magnitude of the Evershed effect. On three occasions rather large Doppler displacements were found. If the velocity is directed parallel to the solar surface, these velocities are comparable with the velocity of sound at the photospheric level.

15459 PHOTOMETRY OF THE CONTINUOUS SPECTRA OF SUNSPOTS IN THE SPECTRAL REGION 4000A-8600A. P.Stumpff.

Z. Astrophys. (Germany), Vol. 52, No. 2, 73-109 (1961). In German.

In 1956/57 photographs of the complete sunspot spectrum were made in the range 4000-8600 A with the concave-grating (dispersion 2.5 A/mm) of the Göttingen solar tower (diameter of solar image 23 cm). The paper deals with the intensity distribution in the continuum of 5 spots (one in 4 positions, each of the others in 1 position on the disc). It is very essential to correct the measurements for scattered light. A method is therefore developed that takes into account the spot geometry in all details. The approximate formulae applied by Michard contain an error leading to undercorrection of his measurements. This error probably also effects Michard's sunspot model. From the new observational material the following results may be derived: (1) The intensity-ratio spot to photosphere seems to show a discontinuity of about 12% between 4500 and 5000 A. (2) The uncertainty in the determination of the scattering function affects the scattering correction of the measurements more than previously assumed. With the present state of observational methods it is therefore difficult or rather impossible to derive the centre-limb-darkening of the spot continuum, i.e. the dependence of temperature upon depth. (3) From the energy curve approximate values of the boundary temperature of spots can be derived, increasing from 2700° to 3600° as the area of the umbra decreases from 150 to 50 millionth of a hemisphere.

15460 THE DETERMINATION OF GAS PRESSURE IN SUNSPOTS FROM THE WING STRENGTH OF FRAUNHOFER LINES. F.van't Veer.

Z. Astrophys. (Germany), Vol. 52, No. 3, 165-85 (1961). In German.

The wings of five selected strong and medium strong Fraunhofer lines are studied in the umbra of sunspots and in the undisturbed photosphere at the same distance from the limb. It appears to be possible to interpret the ratio c/c^* of the strengths of the wings in photosphere and sunspot as a measure for the ratio of the gas pressure if the temperature model is known. For the two spots studied in this paper coherent results were obtained from the five Magnesium and Iron lines. On the basis of a constant difference $\Delta\Theta = 0.26$ a pressure model is derived for a sunspot with a standard area of 80×10^{-6} hemispheres. For equal optical depths the gas pressure in the sunspot is somewhat lower than in the photosphere while the transparency is greater and decreasing less rapidly with increasing depth. A discussion of the influence of the magnetic field in the spot is given. The effect of scattered light of the photosphere on the strength of the wings has been estimated.

15461 SOME REMARKS ON THE METHODS OF RESEARCH INTO THE PERIODICITY OF SUN-SPOTS. M.Kopecký.

Ann. Astrophys. (France), Vol. 24, No. 1, 64-7 (1961).

From the physical point of view, the relative numbers and total areas of sun-spots are unsuitable for research into the periodicity of sun-spots, because they are a conglomerate of various, physically primary, quantities. The method of superposing periods is unsuitable for research into the periodicity of sun-spots, because it is contrary to the physical character of the relative number and total area of sun-spots. The application of other statistical methods only useful, if they proceed from a physical analysis of the pro under examination and the material which is elaborated. Furth research into the periodicity of sun-spots will be justified only physically substantiated characteristics of sun-spots are used, for instance the frequency of sun-spot formation and the averag importance of sun-spots (quantities the examination of which ha already resulted in important physical conclusions), or the mag properties of sun-spots, etc. Further research, restricted only relative numbers and total areas of sun-spots will finally lead t stagnation in this field of solar research.

15462 THE STRUCTURE OF SUNSPOT PENUMBRAS. I. OBSERVATIONS. R.E.Danielson.

Astrophys. J. (USA), Vol. 134, No. 2, 275-88 (Sept., 1961).

In continuation of Project Stratoscope, the 12-in. solar tele first flown in 1957 was again flown to an altitude of 80 000 ft dur four unmanned balloon flights in 1959. The main new feature of these flights was the addition of television, telemetry, and comm channels which enabled the airborne telescope to be operated by remote control from a ground station. As a result, high-definit time sequences of sunspots were obtained. The penumbra is resolved into a complex array of predominantly radial bright filaments. These filaments are long, narrow structures having widths of 300 km or less and lengths of the order of 5000 km. Their lifetime is roughly five times that of the granules.

15463 THE STRUCTURE OF SUNSPOT PENUMBRAS. II. THEORETICAL. R.E.Danielson.

Astrophys. J. (USA), Vol. 134, No. 2, 289-311 (Sept., 1961).

Linearized equations derived by Chandrasekhar (1952) describing convection in the presence of a magnetic field were u to derive growth rates of convection cells (of various sizes and shapes) as a function of the magnetic number Q and the Rayleigh number R. From these growth rates, it is found that the onset o unstable modes (as contrasted with overstable modes) occurs al a curve in the R,Q plane which lies between the overstability-curve and the curve derived on the principle of exchange of stabilities. This curve is the locus of points where the frequenc of oscillation of overstable modes becomes zero. These calcula are applied to the penumbra of sunspots, assuming a uniform magnetic field of 1000 gauss and physical parameters appropria to the outer layers of the convection zone. It is found that convection rolls (long, narrow convection cells) will result if the magnetic field in the penumbra is horizontal or nearly horizont as the Evershed effect strongly suggests. These convection rol are shown to be consistent with the known properties of the penumbral filaments. Some other plausible models of the penu are shown to inadequate.

15464 THE SOLAR CYCLE AND THE ASSOCIATED BEHAVIOURS OF SUNSPOTS AND PROMINENCES. A.K.Das.

Kodiakanal Obs. Bull. (India), No. 152, 149-61 (April 11, 1959).

Deals principally with two specific problems of solar physi (a) the equatorward drift of sunspots according to the Carringto Spoerer law and (b) the general poleward movement of prominer recently established by d'Azambuja and d'Azambuja (1948). On basis of his theory of magnetohydrodynamical waves Alfvén ha attempted to explain the above phenomena, but his explanations much too complex and, in any case, not really satisfactory. In f there exists no altogether convincing theory capable of accounti for these two and a number of other related solar phenomena; i present state of affairs, therefore, it is permissible to construc new models and new theories which seem promising. The prese paper aims to show that the two aforementioned phenomena adm a fairly simple explanation on a theory based upon straightforwa classical dynamics. The purely dynamical considerations here sented lead to the conclusion that on the photosphere there ough exist a resultant acceleration directed from either pole towards equator, while on the chomosphere a resultant acceleration dir from the equator towards the poles should be expected to occur. magnitudes of these accelerations at different latitudes on the s are calculated by using the well-established values of angular v city at the corresponding heliographic latitudes according to me urements made at the Greenwich Observatory; it is shown that t observed rates of equatorward drift of sunspots and of poleward motion of prominences at different heliographic latitudes are nc consistent with the corresponding velocities derived from the th here proposed. With the help of the two oppositely directed acc tions at the two levels and the general dynamical mechanism ad

by the author in earlier papers dealing with a variety of solar ems a broad qualitative explanation is also suggested of the ation of bipolar sunspots, of the simultaneous occurrence of site magnetic polarities in sunspots of the northern and southern spheres, and of the 22-year cycle of reversal of the magnetic ities of sunspots. From the same dynamical mechanism it ars quite natural that sunspots should be associated with photo- ric faculae and the chromospheric flocculi. The peculiar motion ses, known as the Evershed-effect, from the umbral region to eriphery of a sunspot parallel to the photospheric surface also mes intelligible on the basis of this mechanism.

15465 VARIATIONS IN RADIOCARBON CONCENTRATION AND SUNSPOT ACTIVITY. M.Stuiver.

ophys. Res. (USA), Vol. 66, No. 1, 273-6 (Jan., 1961).

Variations in cosmic-ray intensities will produce variations in oduction in the atmosphere. A comparison is made between ations in sunspot activity and fluctuations in C^{14} concentration ng the past 13 centuries. Although a definite conclusion is not hed, the evidence given suggests some correspondence between spot activities and C^{14} concentration in the atmosphere.

15466 CONTRIBUTION TO THE STUDY OF THE KINEMATICS OF THE MATERIAL IN SUNSPOTS AND GRANULES.

rvajean.

. Astrophys. (France), Vol. 24, No. 1, 1-39 (1961). In French.

The observational techniques and instruments used at Meudon at the Pic du Midi are described, together with the instruments d to reduce observations used in a series of studies concerning Evershed effect. Firstly, the variation of the Evershed effect depth is considered. The effect was measured for a number of s in a sunspot spectrum, and the effective optical depth τ of nation of line calculated. Using Michard's model, τ and the rshed effect are expressed in terms of geometrical depth in the umbra. Next, an attempt to determine the velocity field in a plex sunspot is described. Then very detailed observations of a gle roundish spot during its transit across the disk are used to culate the mean components of velocity as a function of distance m the centre of the spot. The method is similar to the one given Plaskett. It is shown how it is possible to reduce considerably amount of work needed to solve the least squares equations, by uitable choice of the points to be measured in the spot. The results w a variation of the horizontal component not very different from vious results; a small vertical downward component is found, ch appears not to have been suspected before. A change of rshed effect with distance of the spot from the centre of the disk s found, in agreement with previous statistical results by Michard. nodification of line profiles in the penumbra associated with the rshed effect is dealt with; it is thought that it results from the dient of velocity with depth in the line-forming layers. In a ond part, high definition spectra taken at Pic du Midi are used in tatistical study of the relations between the intensity of photo- eric granulation, small scale Doppler shifts, and fluctuations of ivalent width for a few lines. Doppler shifts were measured on the ectra by a method of differential photometry involving two micro- otometer tracings in the two wings of the line. Bright granules are erally associated with ascending motions and the reverse is still re evident; but there is no quantitative relation between brightness d velocity. The equivalent width is found to be inversely propor- nal to continuum brightness. Autocorrelation functions for con- uum intensity and Doppler shifts have been calculated: the locity function might have a minimum for a distance of 10 000 km.

15467 THE TEMPERATURE FLUCTUATIONS IN THE SOLAR GRANULATION. J.Bahng and M.Schwarzschild.

trophys. J. (USA), Vol. 134, No. 2, 337-42 (Sept., 1961).

A new measurement of the r.m.s. intensity fluctuation in the anulation was made from a photograph obtained on the Stratoscope ght of September 24, 1959. After correcting this measurement the effects of the instrumental profile, the r.m.s. temperature ctuation in the granulation is found to be $\pm 92^{\circ}$ K.

15468 LIFETIME OF SOLAR GRANULES. J.Bahng and M.Schwarzschild.

trophys. J. (USA), Vol. 134, No. 2, 312-22 (Sept., 1961).

A time sequence of high-definition photographs of the solar anulation was obtained on the Stratoscope flight of August 17, 59. The correlation function in time for the photospheric ensity variations was determined from these photographs. The rrelation function was found to be well represented by a simple ponential decay with a time constant of 6.27 min. If the average lifetime of granules is defined as twice the time interval in which the correlation drops to half, then this lifetime is found to be 8.6 min.

15469 ON THE CENTRE-LIME VARIATION OF GRANULE CONTRAST. R.G.Giovanelli.

Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 523-5 (1961).

It is shown that the observed centre-limb changes in granule contrast, and particularly the disappearance of granulation near the limb, are due mainly to foreshortening and finite telescope resolution. Without greatly improved resolution, it is invalid to use such observations for inferring the optical depth of the top of the granulation zone, as has sometimes been done.

15470 THE CENTRE-LIMB VARIATION OF THE BALMER LINES Hα-Hδ OVER THE SOLAR DISK. K.H.David.

Z. Astrophys. (Germany), Vol. 53, No. 1, 37-67 (1961). In German.

The Balmer lines Hα–Hδ were recorded photoelectrically at seven different positions on the solar disk. The wavelength range was $\Delta\lambda = \pm 30$ A. It is shown that an effect of saturation occurs at a line depth of about 5% for line profiles measured at the centre of the solar disk. At the solar limb this effect occurs already at line depths of about 1%. The calculations of the line wings according to Kolb's theory of the line absorption coefficient, taking resonance broadening into account, show excellent agreement with the observations for Hα and Hβ. For Hγ and Hδ it is necessary to introduce an additional continuous absorption in the upper layers of the solar atmosphere in order to get a fit with the observed line profiles as well as with the limb darkening of the continuum for these wavelengths using the temperature model of Elste. It is supposed that the necessary additional absorption at the wavelength of Hγ and Hδ is caused by continua of metals and molecules or by unresolved molecular bands. It is shown that the wings of the Balmer lines are unsensitive against inhomogenities of temperature given for instance by a three-stream model. The curves of contribution to the absorption in the Balmer lines are remarkably narrow and therefore these lines are very useful for testing stellar photospheric structure.

15471 THE CENTRE–LIMB VARIATION OF THE CONTINUUM AT λ = 5893 A AND THE WINGS OF THE Na D-LINES IN SUNSPOTS. W.Mattig and E.H.Schröter.

Z. Astrophys. (Germany), Vol. 52, No. 3, 195-226 (1961). In German.

During the partial solar eclipse of Oct. 2, 1959, four spectrograms in the wavelength-region λ 5893 were obtained at the Einstein tower at Potsdam. The centre–limb variation of the continuous radiation and of the intensity distribution in the wings of the Na D-lines were investigated. The smearing by atmospheric scintillation and by the apparatus function was taken into account. The scintillation parameters σ were very small ($1.''1 < \sigma < 2.''2$). Corrections for light scattering and for the photographic Eberhard effect were applied. The limb darkening from $\cos\theta = 0.4$ to $\cos\theta < 0.05$ is obtained by photographical observations during the eclipse and from $\cos\theta = 1.0$ to $\cos\theta = 0.2$ by photoelectrical records. The observed centre–limb variation of the wings of the Na D-lines was compared with earlier observations and with that predicted by empirical solar models. The relation given by Minnaert for the description of the intensity distribution in the wings of strong Fraunhofer lines by means of a constant c ("wing-strength") was replaced by a new exact formula. The depth-dependence of the selective absorption coefficient $\xi\gamma/\kappa$ for the Na D-lines is derived from the observations. The comparison of $\xi\gamma/\kappa$ with values predicted by empirical solar models is used to get indications for possible NLTE-effects.

15472 CENTRE-LIMB VARIATION OF SOLAR EXCITATION TEMPERATURE AS DERIVED FROM Ti I LINES. S.Sankaranarayanan.

Kodiakanal Obs. Bull. (India), No. 149, 468-75 (Aug. 5, 1959).

The centre-to-limb variation of the equivalent widths of 55 lines of the neutral titanium atom in the wavelength range 5250-4300 A were studied by the curve of growth method. The majority of the lines studied (47 out of 55) show a systematic increase in equivalent width from the centre of the solar disk to the limb; even in the few remaining cases no reliable evidence is found of the existence of a maximum in the variation of equivalent width in the neighbourhood of $\cos\theta = 0.4$. The behaviour of the Ti I lines thus appears to be just the opposite of the Fe lines which, according to previous workers, show a steady decrease from the centre of the disk to the limb. The excitation temperature for the centre of the disk as derived from the Ti lines measured is about 4540° which is in good

agreement with the mean of the temperatures determined by Prouse (1942), Menzel (1938), King and Wright (1947), but is considerably lower than the value obtained by Bruggencate and Houtgast (1941). According to the measurements reported in the present paper the excitation temperature decreases steadily from the disk-centre towards the limb up to the point sin $\theta = 0.96$ where it is about 4080^0K.

15473 HELIUM LINES AT THE EXTREME LIMB ON THE SOLAR DISC. I.Kawaguchi.
Publ. Astron. Soc. Japan, Vol. 12, No. 2, 129-42 (1960).

The helium concentration in the energy level 2^3P is empirically estimated from the absolute intensities of flash lines, allowing for the absence of the D_3-line from the disk spectrum. The non-appearance of the D_3-line on disk, sin $\theta < 0.97$, can be explained by the compensation of absorption of light from the photosphere emission in the chromosphere. The results are compared with the theoretical computations of de Jager and de Groot (1957) and Athay and Johnson (1960).

CONNECTION BETWEEN SOLAR NOISE AND SUNSPOTS. See Abstr. 15548

15474 THE SOLAR LIMB INTENSITY PROFILE. J.E.Gaustad and J.B.Rogerson, Jr.
Astrophys. J. (USA), Vol. 134, No. 2, 323-30 (Sept., 1961).

A new determination of the intensity distribution of the solar limb at λ 5490 A was made from a photograph taken by a balloon-borne telescope. The apparatus function for the telescope is derived from the data. This new determination supersedes that obtained from 1957 balloon-telescope photographs.

15475 VISUAL OBSERVATIONS OF CONTRAST VARIATION OF FILAMENTS WITH SOLAR LIMB DISTANCE. K.Fredga.
Ark. Astron. (Sweden), Vol. 2, Paper 47, 517-26 (1960).

Observations were performed using a polarizing double-image photometer. The position and inclination with respect to sunspots was determined for a large number of filaments, and curves are given showing an agreement between these observations and Becker's theory. An attempt is made to arrive at a formula which could explain the variation of contrast of the filaments with limb distance, taking into account the structure of the filament, its intrinsic luminosity, translucency and a limb darkening function. The method of determining this function and the values of various constants used in the formula is presented. A comparison between visual and photographic measurements of the same filament and also with other investigations is given, the author concluding that for this kind of investigation concerning small intensity variations the visual determination with this photometer is the most accurate and suitable method. M.Kasha

15476 MAGNETIC FIELDS IN A CENTRE OF SOLAR ACTIVITY BEFORE AND DURING AN ERUPTION. R.Michard, Z.Mouradian and M.Semel.
Ann. Astrophys. (France), Vol. 24, No. 1, 54-63 (1961). In French.

The photographic method used in 1959-60 to observe solar magnetic fields with the 9 m spectrograph at Pic du Midi, allows the measurement of longitudinal fields larger than 30-40 gauss, of sight-line velocities larger than 70 m/sec, and qualitative estimates about transverse fields. Six maps of the longitudinal field were obtained for a small sunspot group (April 23 and 24, 1960). During the course of a 1+ flare, rather a serious event for a group of such size, no certain qualitative or quantitative change of magnetic fields could be found. If important field variations are associated with flares, they must occur before the beginning of the Hα emission.

15477 ON PHOTOSPHERIC FACULAE. J.B.Rogerson, Jr.
Astrophys. J. (USA), Vol. 134, No. 2, 331-6 (Sept., 1961).

A group of photospheric faculae were photometered on a solar limb exposure taken by a balloon-borne telescope. These faculae are located at a mean sin $\theta = 0.99$ and are an average 64% brighter than the undisturbed photosphere at the same limb distance. The neighbouring photosphere is found to be brighter than the undisturbed photosphere by about 6%. A simple model for a facula is proposed and discussed. The observations are consistent with the picture that in the facular regions the layers above $\tau = 0.3$ are approximately 900 deg C hotter than normal.

CLASS 3^+ FLARE OF 12 NOVEMBER 1960; EFFECTS ON l.f. PROPAGATION. See Abstr. 16589

15478 A VERY UNUSUAL FLARE ON NOVEMBER 15, 196 S.Nagasawa, T.Takakura, A.Tsuchiya, H.Tanaka and H.Koyama.
Publ. Astron. Soc. Japan, Vol. 13, No. 1, 129-34 (1961).

Reports observations made in white light, in Hα (spectroheliscopically) and at radio frequencies for a very active flare on November 15, 1960.

15479 FLARES ASSOCIATED WITH THE 1960 NOVEMBER EVENT AND THE FLARE NIMBUS PHENOMENON. M.A.Ellison, S.M.P.McKenna and J.H.Reid.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 491-501 (1961).

Outstanding flares occurred on November 10, 12, 15, and 2 1960 in association with an active region and complex spot grou which had its central meridian passage on November 12. The l three of these flares projected into space showers of cosmic-ra which were registered on the earth by neutron monitors at grou level within 30 min after the flare flash, bringing up to ten the number of these events so recorded since February 28, 1942. C magnetic storms of unusual intensity also occurred on Novembe and 13, and again on November 15. The flares of November 10 12 were photographed under excellent conditions on films taken 1 min intervals with the Lyot Hα heliograph at the Royal Obser tory, Cape of Good Hope. These results are analysed and flare light-curves are plotted. A new phenomenon, the flare nimbus, found in association with some Class 3 and 3+ flares recorded the heliograph. This is a dark absorbing halo which begins to s round the flare some few minutes after the filaments have reac their maximum light intensity: its duration is > 1-2 hr and its meter is about 300 000 km. The characteristic properties of th nimbus are described for the five observed cases, July 16, 195 April 1, June 1, November 10 and 12, 1960, and possible causes discussed. There is a strong presumption that the phenomenon the optical counterpart of the cloud of relativistic electrons wh occurrence in the flare region has been postulated by Boischot Denisse (Abstr. 2736 of 1958) in order to account for the radio emission continuum of Type IV.

15480 NEW OBSERVATIONS OF THE b-LINES OF PROMINENCES. M.Waldmeier.
Z. Astrophys. (Germany), Vol. 53, No. 2, 142-50 (1961). In Ger

Continuing former observations, the present paper deals wi the spectrophotometric classification of 254 further prominence The classification is based on the relative intensity of the four b-lines (Mg I, Fe II). The mean heliographic latitude amounts t 22^0 for class I, to 26^0 for class II and to 29^0 for class III. Sunsp prominences, small flares and surges belong to class I; also ac prominences connected with sunspots or centres of attraction a most of the prominences showing high velocities fall under clas Class III contains above all stationary filaments; in the same cl are found the polar prominences. An extremely large flare fell under class V first, then successively under IV, III and II, and finally after having developed into a sunspot-type prominence, belonged to class I.

15481 THE SPECTRUM OF A QUIESCENT PROTUBERAN OBSERVED IN THE SOLAR ECLIPSE OF 15 FEBRUARY 1961. M.Rigutti and D.Russo.
RC Accad. Naz. Lincei (Italy), Vol. 30, No. 4, 487-91 (April, 196 In Italian.

A table is drawn up containing the wavelength and identifica of 71 emission lines. 33 of these lines have not been observed previously in solar prominences, but they appear in spectra of the chromosphere. R.A.Ne

15482 AN INVESTIGATION OF THE TEMPERATURE CO DITIONS IN PROMINENCES WITH A SPECIAL STU OF THE EXCITATION OF HELIUM. E.Tandberg-Hanssen.
Astrophys. Norveg. (Norway), Vol. 6, No. 14, 161-262 (Aug., 19

The excitation of selected spectral lines in active and semi active prominences are studied in order to derive information temperature conditions in such objects. A special study is mad of the excitation of helium in prominences, in flares and in the chromosphere. It is concluded that the chromosphere is not optically thin in the infrared He I, 10830 line. The same applie to strong flares and bright prominences. A homogeneous mode active and semi-active prominences does not satisfy the observ tions. Such prominences are built up of different regions where physical conditions (temperature and/or motion) vary from one region to another. Some comments are made on the possible

rtance of thermal diffusion and thermal conduction on the cs of prominences.

5483 OBSERVATION OF THE SOLAR CORONA BEFORE, DURING, AND AFTER THE TOTAL ECLIPSE OF EBRUARY 1961. A.Dollfus, M.Marin and J.L.Leroy.
Acad. Sci. (France), Vol. 252, No. 22, 3402-4 (May 29, 1961).
rench.
The aspect of the inner corona, observed photographically in e light during totality, was compared with observations made eb. 14 and 16 with a photoelectric photometer. Deviations of coronal profile at eclipse from those observed on the control were noted close to position angle 120°, and on all three days rked discontinuity was present at position angle 330°. This e feature persisted on the solar W limb until Feb. 19, re- aring at the E limb on Feb. 22. D.R.Barber

5484 STUDY OF THE POLARIZATION OF THE CORONA: PRELIMINARY RESULTS OBTAINED DURING THE CLIPSE OF 15 FEBRUARY 1961 BY THE EXPEDITION OF THE RATE ASTRONOMICAL OBSERVATORY AT MONTE CONERO CONA). M.Hack and M.Fracassini.
Accad. Naz. Lincei (Italy), Vol. 30, No. 4, 497-506 (April, 1961).
talian.
The corona was photographed simultaneously with three cameras polarizers with axes parallel to and inclined at angles of 60° t and west of the solar axis. From a sequence of exposures of ation 1, 2, 4, 8, 16 and 32 sec, sets of isophotes were con- ucted and estimates made of the variation of polarization with ance from the centre of the sun in the polar and equatorial ections. Polarization was found to be much less at the poles than he equator and to be greatest at distances of 1.7 to 2 solar radii. R.A.Newing

5485 ON THE POSSIBILITY OF USING MICROPHOTOGRAMS IN THE STUDY OF THE SOLAR CORONA.
.Pasinetti.
Accad. Naz. Lincri (Italy), Vol. 30, No. 4, 507-11 (April, 1961).
talian.
A report of observations made of the solar eclipse of 1961 ruary 15. Apertures of various sizes were used and a series sophotes constructed. R.A.Newing

15486 THE RATIO OF INTENSITIES OF THE GREEN AND RED CORONAL LINES. C.Pecker and R.N.Thomas.
. Acad. Sci. (France), Vol. 252, No. 20, 3000-2 (May 15, 1961).
French.
A theoretical discussion of the role played by the 3s $3p^6\ ^2S_{1/2}$ nsition level of Fe X in the excitation of the red coronal line at 4 A. The rapid variation of the population ratio, N(Fe XIV)/N(Fe X), h electron temperature, namely, from $\sim 9 \times 10^{-4}$ to $\sim 6 \times 10^2$ h T varying from $\sim 6 \times 10^5$ to 12×10^5, is shown to be nificant when considering the intensity ratio, I_{5303}/I_{6374} in coronal ions where Fe XIV is either scarce, or abundant. It is not sible to define coronal "ionization" temperature without a wledge of the way in which the various parameters involved er into the final value of the line intensity ratio, I_{5303}/I_{6374}. In onal physics, "ionization" and electron temperatures are not ivalent. D.R.Barber

15487 SOURCES OF SOLAR ULTRAVIOLET RADIATION. R.G.Athay.
geophys. Res. (USA), Vol. 66, No. 2, 385-90 (Feb., 1961).
Recent work related to the interpretation of the observed solar raviolet radiation is summarized from two standpoints: (1) the rce of energy giving rise to the radiation, and (2) the physical ditions in the solar atmosphere where the radiation originates. a on the ultraviolet spectrum are of great astrophysical portance for determining the energy balance and thermodynamic ucture of the upper solar chromosphere and lower corona, but lack of adequate atomic cross-sections seriously limits the ctical astrophysical usefulness of such data.

15488 THEORY OF X-RAY EMISSION OF THE SUN. G.Elwert.
geophys. Res. (USA), Vol. 66, No. 2, 391-401 (Feb., 1961).
First the temperature T of the corona is discussed, since the ectral distribution of the X-ray radiation depends on the value of The cross-sections for electronic collisions computed by wartz and Zirin for s waves (Abstr. 12958 of 1959) yield an upper limit of T which is 1.3 to 1.4×10^6 °K. In pursuance of earlier calculations of the author the X-ray emission of the corona by free–free and free–bound as well as by line emission is discussed. The theoretical results are compared with the observations. The effect of the radiation in the atmosphere of the earth and the intensity distribution across the solar disk is summed up. The emission of the transient region to the chromosphere and of hot spots is considered. Finally the X-ray radiation during a flare is investigated; some conclusions are drawn from the observations on the physical state the emitting gas.

15489 A MODEL OF THE CORONAL CONDENSATION. K.Kawabata.
Publ. Astron. Soc. Japan, Vol. 12, No. 4, 513-23 (1960).
From a statistical investigation of the slowly varying component (S-component) of the solar radio-frequency radiation, the temperature and the optical depth of the coronal condensation associated with an intense calcium plage are obtained. The temperature of the coronal condensation is found to amount to $4\text{-}6 \times 10^6$ °K. The more intense the calcium plage, the higher the electron temperature. An eclipse observation of the polarization suggests that the magnetic field of more than 1000 G is present only in a small area above the sunspots.

15490 RESULTS OF THE ZÜRICH SOLAR ECLIPSE EXPEDITION 1954. VIII. BRIGHTNESS DISTRIBUTION AND COMPONENT RESOLUTION. M.Waldmeier.
Z. Astrophys. (Germany), Vol. 53, No. 2, 81-94 (1961). In German.
For Pt VII see Abstr. 6714 of 1961. The brightness distribution of the corona from the solar limb out to 30 solar radii is deduced from photometrically calibrated photographs of the corona taken by cameras with focal lengths ranging from 20 cm up to 8 m, as well as from results of other authors. The brightness distribution is separately given for the F- and K-component. The flattening of the F-corona is small, whereas that of the K-corona is large. The decrease of the flattening between R = 1.7 and 3 is not produced by overlapping of the F-component, but is a characteristic feature of the K-corona itself. The effect of the F-component consist merely of a general reduction of the flattening of the K-component.

15491 VERTICAL VELOCITIES IN THE SOLAR CHROMOSPHERE. R.G.Giovanelli and J.T.Jefferies.
Austral. J. Phys., Vol. 14, No. 2, 212-17 (June, 1961).
A $\frac{1}{8}$ A birefringent filter was used to photograph the chromosphere at various wavelengths across the Hα line. A process of photographic subtraction has then yielded photographs of velocity distributions. At all chromospheric depths, there is a close correlation between the intensity of the granules in Hα and the vertical velocity, the darker granules falling.

15492 THE HEATING OF THE SOLAR CHROMOSPHERE, PLAGES, AND CORONA BY MAGNETOHYDRODYNAMIC WAVES. D.E.Osterbrock.
Astrophys. J. (USA), Vol. 134, No. 2, 347-88 (Sept., 1961).
The energy radiated from the chromosphere, the corona, and the upper chromosphere is approximately estimated from observational data. The energy carried upward by sound waves generated in the hydrogen convection zone is estimated and found sufficient to balance these losses, though the numerical result is highly uncertain because of its great dependence on the turbulent velocity field. The spectrum of this noise is a broad band with maximum near the frequency of 0.01 c/s. The waves propagate in the so-called "fast" mode and become increasingly magnetohydrodynamic in character as they run out through the chromosphere, because of the negative density gradient. Little, if any, energy is emitted by the hydrogen convection zone in the "slow" or "Alfvén" modes, and these modes are, in addition, strongly absorbed in the photosphere. The cross-sections for collisions between neutral atoms and ions in the chromosphere is large, and, as a result, the dissipation of the fast-mode waves by the frictional damping mechanism is very small. The waves build up to shocks, and the dissipation of these shocks is the main energy source for the chromosphere. The dissipation of the shocks is worked out by using a similarity principle, in a way analogous to the Brinkley–Kirkwood theory of the dissipation of pure gas-dynamic shocks. At great heights, where the magnetic field dominates, the shocks become weaker, the dissipation decreases, and the rays are refracted back downward toward the photosphere. However, at these heights, collisions between shocks must be expected to feed some energy into the slow mode and the Alfvén mode, and these modes then propagate straight

up the magnetic line of force, with essentially no weakening by refraction, and carry energy into the corona. The plages are regions of large magnetic field, where there is extra generation of noise in the hydrogen convection zone below and where the refraction and shock-collision effects are more important. The spicules seen at the limb of the sun are interpreted as slow-mode disturbances carrying chromospheric material up along the magnetic lines of force into the corona.

15493 TRAJECTORIES OF CHROMOSPHERIC DISK SURGES. J.M.Malville and G.E.Moreton.
Nature (GB), Vol. 190, 995 (June 10, 1961).

A cinematographic study of chromospheric surges in Hα light has made possible identification of a new group of complex disk surges that, unlike the straight, brush-like features associated with adjacent flare regions, appear as irregular dark mottlings. These are best viewed when the band-pass of the interference filter is displaced by 0.5 A on either side of Hα. Ejection velocities of 100 km sec^{-1} are found in the mottled zones; and the trajectories of individual surges appear to be dominated by local magnetic fields. Although further research is needed to establish a detailed connection between surges and associated magnetic field it is clear from the observations already made that the complex surges may be used as "test particles" for mapping chromospheric, and coronal magnetic fields. D.R.Barber

15494 SOLAR CORPUSCULAR RADIATION AND POLAR IONOSPHERIC DISTURBANCES. T.Obayashi and Y.Hakura.
J. geophys. Res. (USA), Vol. 65, No. 10, 3131-42 (Oct., 1960).

Study of disturbances in the polar ionosphere yields considerable evidence of the existence of energetic solar particles associated with solar flares. Radio blackouts due to enhanced ionizations are classified into two characteristic types: the polar-cap blackout, and the auroral-zone blackout. It is shown that the polar-cap blackout appears with some hours' delay after a major solar radio outburst of type IV, and is confined within the geomagnetic latitude of about 60° to 65°. The estimated energies of particles causing it are of about 10 to 100 MeV. The auroral-zone blackout then follows, accompanied by geomagnetic storms and auroras; it may be caused by the so-called auroral particles of 1 MeV or less. The energy spectrum of solar particles associated with solar flares is discussed in view of the present results and of information from various observations of solar and terrestrial disturbances. It is concluded that solar particles have a conspicuous suprathermal non-Maxwellian tail extending from a few keV up to relativistic energy ranges, though the main part of corpuscular clouds consists of particles of rather low energy, which therefore are likely to be in the Maxwellian distribution. The nature of solar corpuscular clouds and their effect upon the terrestrial ionosphere are also discussed.

15495 NEUTRINO EMISSION PROCESSES, STELLAR EVOLUTION AND SUPERNOVAE. I. H.Y.Chiu.
Ann.Phys. (USA), Vol. 15, No. 1, 1-21 (July, 1961).

A general qualitative discussion of evolution of stars of masses < 1.4 solar mass is presented. The role of gravitational contraction has been emphasized with respect to element synthesis. It is found that most of the stars with masses above a few tenths solar mass will proceed through all phases of element synthesis and consequently will become a supernova. The URCA process suggested by Gamow and Schönberg in 1941 will change this picture. During the α-process of element synthesis the rate of gravitational energy release is of the same order as that lost due to URCA neutrinos, and the critical mass for a supernova is not certain, although the upper limit of it is less than the Chandraskhar mass limit for degenerate gas spheres. The URCA process energy dissipation rates of a number elements have been calculated for $T = 6 \times 10^8$, 1.2×10^9, 2.4×10^9, and 6×10^9 °K, respectively.

15496 THE TIME RATE OF FORMATION OF STARS. S.von Hoerner.
Fortschr. Phys. (Germany), Vol. 8, No. 4, 191-244 (1960). In German.

In the course of an investigation of the rate R(t) of star formation per unit volume throughout the galaxy, a detailed examination is made of the dependence of stellar velocities in the solar neighbourhood upon spectral class and luminosity, and a positive correlation is found between the age of a star and all three of its component velocities. Observed velocity distributions are used to estimate the variation in gravitational potential in a direction perpendicular to the galactic plane, and a luminosity distribution function, averaged i this direction, is obtained. The derived values for R(t) show the of star formation to have been initially about ten times the pres value, R(t) decreasing rapidly during the first 10^9 years and rem ing approximately constant for the last 4×10^9 years. The sam general behaviour of R(t) is obtained in an investigation based o assumption that R(t) is proportional to the square of the mean density of interstellar gas. Independent confirmation of an initi high rate of star formation is derived from consideration of the distribution of helium in the sun's neighbourhood and the freque of white dwarfs, and also from calculations of an average veloci for stars. R.A.Ne

15497 ON THE PERIOD OF RADIAL PULSATION OF WHI DWARFS. E.Schatzman.
Ann. Astrophys. (France), Vol. 24, No. 3, 237 (1961). In French

Computation of the period of the radial pulsations of white dwarfs for different values of the parameter of internal structu $1/\gamma_0^2$. Corrections are given to former publications.

15498 A NOTE ON EQUATORIAL ACCELERATION IN A MAGNETIC STAR. L.Mestel.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 473-8 (19

A rotating star has initially a purely poloidal magnetic fiel Meridional circulation of matter causes non-uniform rotation, which in turn generates a toroidal component of field and so a toroidal magnetic force. The possible steady states are studied is shown that if the circulation speed is less than the local Alfv speed (defined by the poloidal field), then flow along a field line parallel to the surface will cause a steady increase of angular velocity towards the equator.

15499 RADIAL OSCILLATIONS OF A COMPOSITE MODE H.S.Gurm.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 480-5 (Sept. 26, 19

Small adiabatic radial oscillations of a composite configura are investigated. The model consists of a homogeneous core of finite extent and density surrounded by an envelope of finite den varying inversely as the square of the distance from the centre star. Considering the general motion, it is shown that the mode capable of oscillating as a whole in different frequencies withou any restriction being imposed on the ratio of the radii as found previously by other investigators.

15500 ANHARMONIC PULSATIONS OF A COMPOSITE MODEL. H.S.Gurm.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 497-501 (Sept. 26,

The anharmonic pulsations of a composite model, consistin a homogeneous core of finite extent and density with an envelop which the density varies inversely with the square of the distan from the centre, are considered. A solution in terms of Fourie series is obtained by numerical methods for the particular cas $b = 0.5$. It is found that λ, the ratio of the time of rise of the ra velocity from the minimum to the maximum to the total period, 0.44 for the curve and the increase in the period is 1.32% of the period of the fundamental mode of the small radial oscillations.

15501 UNIDENTIFIED LINES IN SPECTRA OF SUN AND STARS. P.W.Merrill.
Astrophys. J. (USA), Vol. 134, No. 2, 556-62 (Sept., 1961).

Many unidentified lines occur in published lists of lines in solar and stellar spectra. The more outstanding ones, both bri and dark, with the main sources in which they have been found listed in tabular form.

15502 SOME REMARKS ON THE DETERMINATION OF INTENSITY IN THE WING OF A STRONG ABSORPT LINE. F.van't Veer.
C.R. Acad. Sci. (France), Vol. 252, No. 26, 4117-19 (June 26, 19 In French.

It appears that the new definition of intensity introduced by Mattig and Schroter [Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 7, 391-8 (1960)], is equivalent to Minnae G.A.Chi

15503 THE INFLUENCE OF RESOLVING POWER ON THE DETERMINATION OF THE CONTINUOUS BACKGROUND IN A STELLAR SPECTRUM. A.M.Rozis-Saulgeot.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 76-7 (July 3, 1961). In French.

Based upon the limiting resolving power (R = 0.5 A) obtaine

erimentally from measurements of a high-quality high-dispersion A/mm) spectrogram of β Cassiopeiae (spectral type F2), numer- values of the ratio, I'_λ/I_λ (where I' and I_λ are the observed and e intensities of spectral continuum at wavelength λ) are computed values of R between 10 and 30 A. They cover the normal range alues met with in low-dispersion stellar spectrograms where the olution attainable is not limited by the dispersive system but by width of entrance slit required to admit sufficient light for the tographic exposure. The ratio, I'_λ/I_λ is found to decrease with reasing resolving power, and also with decreasing λ. For mple, if I'/I = 1 for R = 0.5 at 5000 A, the corresponding value of ratio at 4200 A will be 0.905. For R = 20 A, respective values he ratio I'/I are 0.936 at 5000 A, and 0.809 at 4200 A.

D.R.Barber

15504 THE INFLUENCE OF RESOLVING POWER ON THE DETERMINATION OF A [STELLAR] SPECTROPHOTO- :TRIC GRADIENT. A.M.Rozis-Saulgeot.
. Acad. Sci. (France), Vol. 253, No. 2, 221-3 (July 10, 1961). French.

See preceding abstract. It is shown by numerical calculation t systematic errors occur when using log intensity-ratio values ived from stellar continuum measures in low-dispersion spectra the evaluation of spectrophotometric gradients. Gradient correc- ns, expressed as log (I'_λ/I_λ), are tabulated for selected mean adient wavelengths from 4019 to 5900 A. The corrections range m 0.038 at 4019 A to 0.023 at 5900 A. D.R.Barber

15505 VIBRATIONAL TRANSITION PROBABILITIES OF THE $^1\Pi_u - ^1\Sigma_g^+$ SYSTEM (PHILLIPS SYSTEM) OF CARBON OLECULE. F.Kamijo.
bl. Astron. Soc. Japan, Vol. 12, No. 3, 420-6 (1960).

Vibrational transition probabilities of $^1\Pi_u - ^1\Sigma_g^+$ system hillips system) of C_2 molecule are calculated, on the assumption at potential energy functions are represented by the Morse tential. Overlap integrals are obtained graphically for the bands (2—0), (3—1), (4—1) and (5—2), which have been observed in the ellar spectra. For (0—0), (1—0) and (0—1) bands, values of the brational transition probabilities above cited are estimated, and e possibility of their presence in a stellar spectrum is suggested.

15506 REMARKS ON THE ORIGIN OF POLARIZATION OF STARLIGHT. A.Behr.
Astrophys. (Germany), Vol. 53, No. 2, 95-105 (1961). In German.

In a recent paper Thiessen [Astr. Abh. Hamburg Vol. 5, No. 9, 961)] has proposed a new hypothesis explaining the polarization starlight by synchrotron radiation in stellar atmospheres rather an by scattering of light in interstellar space. It is shown, wever, that most of his arguments must be rejected and that there no reason to abandon the assumption of the interstellar origin polarization. His fan-shaped polarization diagrams are due only a special selection of stars; they become quite irregular, if more ars are considered. The dependence of polarization on spectral pe found in Behr's observations disappears if the distances of the ars are taken into account. Some detailed objections against iessen's theoretical arguments are made.

15507 ON THE EFFECT OF A HELICAL MAGNETIC FIELD ON THE POLARIZATION OF STARLIGHT. J.G.Ireland.
onthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 461-72 (1961).

The observational data on the interstellar polarization of star- ght is shown to be generally favourable to a helically twisted model the spiral arm magnetic field. The data is, in some respects, riously opposed to the normal cylindrical model. There is also idence that a halo field dips through the galactic plane in interarm gions.

15508 PROPAGATION OF INTENSE SHOCK WAVES IN STELLAR ENVELOPES.
.S.Bhatnagar and R.S.Kushwaha.
nn. Astrophys. (France), Vol. 24, No. 3, 211-18 (1961).

The theory of shock wave propagation given by Brinkley and irkwood in 1947 has been developed to take into consideration the teraction of material gas with radiation, which is necessary for s application to stars. The radial velocity has been computed from e decay of shock waves in the atmosphere of the β-Cephei star, W Vulpeculae, and has been compared with the observed radial locity curve of this star. The agreement is found to be good and e computed time for decay of the shock wave is of the order of the riod of the observed variations.

15509 MODEL OF THE STELLAR CONVECTIVE ZONE. P.Souffrin.
C.R. Acad. Sci. (France), Vol. 252, No. 20, 2997-9 (May 15, 1961). In French.

In order to examine the effect of boundary conditions upon the degree of instability, a three-layer model is considered in which an unstable polytropic region is bounded above and below by semi-infinite stable isothermal zones. R.A.Newing

15510 CONVECTIVE INSTABILITY IN POLYTROPIC ATMOSPHERES. I. W.Unno, S.Kato and M.Makita.
Publ. Astron. Soc. Japan, Vol. 12, No. 2, 192-202 (1960).

15511 CONVECTIVE INSTABILITY IN POLYTROPIC ATMOSPHERES. II. S.Kato and W.Unno.
Publ. Astron. Soc. Japan, Vol. 12, No. 3, 427-40 (1960).

15512 A THEORY FOR NON-GREY ATMOSPHERES. W.Unno and Y.Yamashita.
Publ. Astron. Soc. Japan, Vol. 12, No. 2, 157-67 (1960).

A new method is developed to construct a non-grey model atmosphere directly without using an initial grey model.

15513 A THEORY FOR NON-GREY ATMOSPHERES. II. W.Unno.
Publ. Astron. Soc. Japan, Vol. 13, No. 1, 66-75 (1961).

The treatment in Pt I (see preceding abstract) is improved by including an additional exponential term in the source function which was formerly assumed to be a linear function of the optical depth. The temperature distribution is expressed in terms of the optical depth together with various mean absorption coefficients weighted differently. The non-grey model is shown to have much lower temperature within a thin surface layer and somewhat higher temperature in deeper layers, compared with the corresponding grey model, provided the degree of non-greyness is large.

SOLUTION OF NON-GREY RADIATIVE TRANSFER PROBLEMS IN STELLAR ATMOSPHERES. See Abstr. 15750

ABSORPTION COEFFICIENT OF A STELLAR ATMOSPHERE. See Abstr. 15751

15514 ON THE TURBULENCE AND HYDROMAGNETIC TURBULENCE IN ASTROPHYSICS. H.Shimooda.
Publ. Astron. Soc. Japan, Vol. 12, No. 2, 168-91 (1960).

The definition of "turbulence" suitable to the astrophysical observations is given from the hydrodynamical point of view. For the turbulence in astrophysics it is necessary to derive both the velocity of the mean motion from the line profiles and the standard deviation of the fluctuation velocity for the mean motion from the curve of growth. A criterion for the hydromagnetic turbulence to arise spontaneously in the stellar atmospheres is given and a theoretical interpretation of the hydromagnetic turbulence for the two extreme cases (i.e. time-independent and -dependent cases) of the stellar atmosphere is described. The method of this theoretical interpretation is applied to turbulence phenomena due to solar granulation. The size of the largest eddy element in the instability zone is examined using the Rayleigh criterion. Richardson and Schwarzschild's observation (1950) is thus interpreted as a time-average of the time-dependent turbulence and the effective mean magnetic field intensity in the solar granulation is estimated, in satisfactory agreement with some essential characters of Babcock and Babcock's observation (1955). The physical mechanism of the hydromagnetic turbulence and an ordered transient motion in the solar granulation, as well as other subjects closely related to turbulence phenomena, are briefly discussed.

15515 THE S- AND T-FUNCTIONS OF S. CHANDRASEKHAR. S.Ueno.
Publ. Astron. Soc. Japan, Vol. 12, No. 3, 415-19 (1960).

Discusses a pseudo-paradox of the invariance technique for a homogeneous atmosphere of optical thickness $\tau_1 - \tau_0$ $(0 \leq \tau_0 < \tau_1)$. Assuming a monodirectional illumination of the surface $\tau = 0$, Chandrasekhar derived integral equations governing the S- and T-functions from the principles I and IV of invariance. Making use of the axial symmetry of the radiation field about an axis perpendicular to the stratification and passing to the limit $\tau_0 \to 0$, these equations can be obtained from the above principle for a monodirectional illumination of the surface $\tau = \tau_1$, because of the constant optical property of the medium. In the inhomogeneous case the above does not hold, because of the polarity of the S- and T-functions.

15516 S.NTHESIS OF IRON GROUP ELEMENTS BY THE RAPID NUCLEAR PROCESS.
M.Nishida, H.Tsuda and H.Tsuji.
Progr. theor. Phys. (Japan), Vol. 24, No. 3, 685-7 (Sept., 1960).

An attempt is made to explain the cosmic abundances of elements in the iron peak in terms of rapid nuclear processes taking place in the initial phases of a supernova explosion.

R.A.Newing

15517 A SPECTRAL STUDY OF SOME PLANETARY NEBULAE IN THE PHOTOGRAPHIC INFRARED.
Y.Andrillat and H.Andrillat.
Ann. Astrophys. (France), Vol. 24, No. 2, 139-47 (1961). In French.

Microphotometer tracings (with line identifications) of ten representative nebulae are reproduced. The spectra were taken with a new grating spectrograph (300 lines/mm) at a constant dispersion of ~ 280 A/mm, on Eastman IN plates. They present a great variety of permitted, forbidden and nuclear emission line features.

D.R.Barber

15518 THE HELIUM AND HEAVY-ELEMENT CONTENT OF GASEOUS NEBULAE AND THE SUN.
D.E.Osterbrock and J.B.Rogerson.
Publ. Astron. Soc. Pacific (USA), Vol. 73, 129-34 (April, 1961).

Calculation of the solar O/H ratio, from the widths of the three weak forbidden lines of O I, leads,by way of published relative abundances and Weymann's solar interior calculation (Abstr. 8362 of 1957), to the conclusion that the solar, planetary nebula and interstellar abundances are probably all essentially the same. The suggested original H/He mass ratio is 2.0, giving 0.64 : 0.32 : 0.04 as the proportions of H to original He to heavy elements; this is found as a compromise between somewhat differing data for the sun and for planetary nebulae and Orion Nebula.

J.Hawgood

15519 REPRESENTATION OF STELLAR SYSTEMS BY POLYTROPIC GAS-SPHERES. E.A.Kreiken.
Ann. Astrophys. (France), Vol. 24, No. 3, 219-36 (1961).

An attempt is made to represent stellar systems by polytropic gas-spheres. This implies that the stellar systems are considered to have spherical symmetry. For the galactic system a working model is discussed. Three quantities must be determined: n, the polytropic index; α, the structural constant (Zwicky); and ρ_c, the central density. From the distribution of the globular clusters within our system the value n = 5 is obtained. The polytropic sphere n = 5 is known as the "Plummer model" due to its extensive use in his studies of the individual globular clusters. The index n = 5 is assumed to hold for all stellar systems. For the local galactic system the numerical values of α and ρ_c are obtained from the stream velocity V_s = 275 km/sec at a distance of 8.2 kpc from the galactic centre and from the mass interior to the point R = 8.2 kpc. The advantage of the Plummer model is that the distribution functions, valid within this model, can be expressed analytically. These expressions are derived both for the unit system (α = 1; ρ = 1) and for the local galactic system. Special attention is paid to the force function which is of the form $g = 3.05 \times 10^{-6} (22 + R^2)^{-3/2}$ dynes. From the relations giving the circular velocity, expressions for the differential effects of galactic rotation are derived. For the galactic system a high temperature turns up. This is considered to be the external temperature T_e of the galactic clouds and corresponds to the large scale turbulent motions of the clouds. In one case also (Pleiades) the internal temperature T_i of a cloud can be evaluated and for this a low value is found. T_i corresponds to the internal velocities within a cloud and is the temperature observed in radioastronomy. The model n = 5 is next applied to some well-known external galaxies and to clusters of galaxies. In all cases reasonable values turn up. This proves that formally at least stellar systems are correctly represented by the model n = 5. It will be necessary to study some of the dynamical properties of the model and compare these with observations before it can be decided to what extent the solution is also correct physically.

15520 THE LUMINOSITY FUNCTION OF STAR FORMATION.
S.van den Bergh.
Astrophys. J. (USA), Vol. 134, No. 2, 553-5 (Sept., 1961).

A comparison is made between the luminosity functions of galactic clusters and the luminosity function of unevolved field stars. This comparison shows that galactic clusters contain fewer faint stars than the general stellar population in the vicinity of the sun. Some possible implications of this result are briefly discussed.

15521 THE MEASUREMENT OF RADIAL SPEEDS OF GALAXIES WITH THE ELECTRON CAMERA.
R.Duflot-Augarde.
C. R. Acad. Sci. (France), Vol. 253, No. 2, 224-5 (July 10, 1961). In French.

Measurements relate to galaxies whose radial speeds have determined also by other methods. Comparison of the results s that the electron camera gives good results without introducing supplementary errors.

G.A.Chi

15522 SUPERNOVAE.
V.C.Reddish.
Sci. Progr. (GB), Vol. 49, 447-51 (July, 1961).

A brief review of recent researches by Hoyle and Fowler (Abstr. 2638 of 1961) and Colgate and Johnson (Abstr. 17437 of 1 The alternative hypotheses are outlined, and divergencies point out. Two different types of supernovae exist, types I, and II originating in older, and younger stellar systems respectively. latter predominate in the gas-rich arms of spiral nebulae. Both types reach a maximum brightness at outburst of $\sim 10^9$ times th of the sun. The gaseous ejecta of type I outbursts contain little no H, and are expelled with velocities around 2000 km sec^{-1}, whereas the type II material is H-rich, and is expelled with a velocity ~5000 km sec^{-1}. Observed kinetic energies are 2×10^5 for type I, and some thousand times greater for type II outburst Hoyle and Fowler differentiate between these two types by argu that implosion only occurs in massive stars ($30 \times M_\odot$, or more that the lighter elements can reach explosive temperatures only the degenerate material present in less massive stars. Against Colgate and Johnson attribute the source of energy in type II out bursts to the gravitational energy released by the collapse of th stellar core rather than to rapid nuclear reactions of the light elements present.

D.R.Ba

Radioastronomy

15523 RADIO ASTRONOMY AND COSMOLOGY.
M.Ryle.
Nature (GB), Vol. 190, 852-4 (June 3, 1961).

The cosmological problem is briefly reviewed with special reference to the possibility of distinguishing between steady-stat and evolutionary theories by means of radio astronomy. The wo the Cambridge instrument is described, and it is reported that t observed intensity distribution of extra-galactic radio sources suggests that modifications are required in the steady-state mod

R.A.Ne

15524 RADIOASTRONOMICAL METHODS.
P.G.Mezger.
Nachrichtentech. Z. (NTZ), (Germany), Vol. 13, No. 12, 579-91 (Dec., 1960). In German.

A short but comprehensive survey of radioastronomy.

H.J.A.Chi

STATISTICAL ANALYSIS OF RADIO STAR SCINTILLATION
See Abstr. 15266

15525 ARRAY OF SIXTEEN AERIALS WORKING AT 9300 M AT THE NANÇAY RADIOASTRONOMY STATION.
M.Pick and J.L.Steinberg.
Ann. Astrophys. (France), Vol. 24, No. 1, 45-53 (1961). In Fren

A radiotelescope designed for solar observations on 3 cm wavelength is described. The aerial is a 16 element array with resolving power of 4'.5 and a meridian mounting. From the dat obtained since February 1958 it is possible to estimate the altit duration, brightness and variations with heliographic longitude o condensations radiating centimeter waves.

15526 METHOD FOR PUTTING THE ELEMENTS OF AN AERIAL SYSTEM IN PHASE.
É.J.Blum, J.Delannoy and M.Joshi.
C.R.Acad. Sci. (France), Vol. 252, No. 16, 2517-19 (April 24, 1 In French.

The method involves observing a point radio source using t aerial system which is being measured and a single "reference" aerial. By studying the Fourier transforms of the output signal it is possible to localize the principal faults in the phasing of th array.

H.J.A.Chi

5527 THE RADIO TELESCOPE INTERFEROMETER AT THE ROYAL RADAR ESTABLISHMENT. J.S.Hey.
ire (GB), Vol. 190, 1150-2 (June 24, 1961).
The installation at Malvern consists of two paraboloids, 25 m iameter, movable along intersecting tracks respectively 1500 m 750 m long. Ways of using the instrument are described.
H.Rishbeth

15528 THE CROSS-ANTENNA OF THE PROPOSED BENELUX RADIO TELESCOPE.
J.Christiansen and J.A.Högbom.
ure (GB), Vol. 191, 215-17 (July 15, 1961).
The instrument is to have aerial arrays of length 5 km, which e a resolution of 1' of arc at 73 cm wavelength. It will have eral separately usable beams, steerable by means of the phasing angements outlined in the paper.
H.Rishbeth

15529 NOTES ON THE RADIATION PATTERN OF PARABOLIC MIRRORS IN CONJUNCTION WITH RE-SETTING OF DIOASTRONOMICAL EQUIPMENTS. G.Koch.
aer Jahrbuch (Germany), 1959 II, 474-9. In German.
The relative movements of the radio sources during the measure-nts of the intensity of radiation demand accurate follow-up and setting of the receiving system; this must lie well within the its of the required reading resolution. An approximate formula btained and a method is given for the evaluation of the main .m. The field distribution method employed for this purpose is atively simple; however, it is not strictly accurate in that scalar her than vectorial magnitudes are used. Since it applies to ge reflectors the approximation is justified in this case.
Z.F.Voyner

15530 THE POSSIBILITY OF OBSERVING FEATURES OF GALACTIC RADIO EMISSION FROM A SATELLITE-ORNE RADIO TELESCOPE. F.G.Smith.
onthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 6, 527-34 (1961).
It has already been proposed to extend measurements of the ectrum of radio emission from the Galaxy to frequencies of about Mc/s by means of a satellite-borne receiver. If the satellite is in e upper ionosphere, where the refractive index is increasing with ight, a focusing effect will occur which may allow individual atures of emission to be observed. It is shown that a beamwidth the order of 20° may be achieved under favourable circumstances; e most important limitation is the frequency bandwidth necessary a sufficiently sensitive receiver, which inevitably means that dis-rsion in the refractive index effectively blurs out any narrower am or any interference effects inside the beam. The experimental nditions needed for the realization of this degree of focusing in a tellite or a rocket flight are discussed. It appears that the fre-ency of a satellite-borne receiver should sweep over a range of out 3 to 5 Mc/s, with a bandwidth of 10 kc/s. The satellite orbit ould be nearly circular, at a height of about 400-500 km.

15531 RAY PATHS FROM A COSMIC RADIO SOURCE TO A SATELLITE IN ORBIT.
B.Haselgrove, J.Haselgrove and R.C.Jennison.
oc. Roy. Soc. A (GB), Vol. 260, 423-34 (March 7, 1961).
A receiver mounted on a satellite in orbit above the maximum the F2 layer can receive radiation of frequencies that are totally flected by the ionosphere. Two effects of reflection in the upper rt of the ionosphere are discussed; both occur particularly when e satellite enters or leaves a region in which it can receive diation from a point source. The first of these effects is focusing, ich will give a very strong signal at these points, and the second interference between the two possible rays from the point source the satellite. The theory of these two effects is discussed and me numerical calculations are described which demonstrate them a particular model ionosphere.

15532 SOLAR RADIOASTRONOMY [RADIOASTRONOMIA SOLARE].
ndiconti della Scuola Internazionale di Fisica "Enrico Fermi", rso XII. Bologna: Zanichelli (1960) 438 pp.
The conference was held at Varenna, Lake Como on July 15-30, 59. Abstracts of the papers presented will be found in this or ceeding issues of Physics Abstracts.

15533 ON THE POLARIZATION OF SOLAR RADIO EMISSION AT 1.5 m WAVELENGTH.
U.J.Alekseev and V.V.Vitkevich.
Radio Astronomy Symposium Paris, 1958 (see Abstr. 10477 of 1960) p. 259-62.
A polarimeter constructed at the Crimean station is described. The degree of polarization of bursts is constant over periods of several days and the polarization is nearly circular. The degree of polarization may show small but significant changes from one burst to the next. The polarization of bright regions is similar to the polarization of the bursts.
R.D.Davies

15534 SCATTERING OF RADIO WAVES IN THE SOLAR CORONA. A.Hewish.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 268-73.
Scattering of the radiation of the Crab Nebula at metrewave-lengths by the sun has been observed at Cambridge from 1952 to 1958. The angular spectrum of the scattering has the form $\exp -(\phi/\phi_0)^2$. The scattering is least during the sunspot minimum. A theory which describes the effects in terms of scattering from irregularities aligned in the solar magnetic field gives fair agreement with the observed results.
R.D.Davies

15535 A POSSIBLE TEST FOR THE EXISTENCE OF THE CHAPMAN CORONA IN RADIO ASTRONOMY.
F.Link.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 274.
The large angular diameter of the Chapman corona may possibly be investigated using refraction effects observed during occultations of the Crab Nebula. A theory of electron refraction gives an estimate of the intensity likely to be observed.
R.D.Davies

15536 NEW DATA ON THE SOLAR SUPERCORONA.
V.V.Vitkevitch.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 275-81.
The measurements of occultations of the Crab Nebula by the sun since 1951 show that the supercorona has an inhomogeneous structure from 4 to 20 solar radii. The electron densities in the inhomogeneities are about 10 times those in the spherically symmetric corona. During sunspot maximum the supercorona is 20% larger than at sunspot minimum. It is concluded that the magnetic field which determines the structure of the irregularities is the same on either side of the sun and therefore cannot be due to a dipole field.
R.D.Davies

15537 ECLIPSE OF THE CRAB NEBULA BY THE SOLAR CORONA. E.J.Blum and A.Boischot.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 282-5.
The occultation was observed in 1957 and 1958 with the 32 element interferometer operating at 168 Mc/s. During the occultation no displacement of the source greater than 30 seconds of arc was observed. The diameter increased from 5 to 15 minutes of arc and moreover the flux of the source increased as the occultation progressed except at the centre of the occultation when the flux fell to its un-occulted value.
R.D.Davies

15538 CONCLUDING LECTURE [PART II—THE SUN]. M.G.J.Minnaert.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 of 1960) p. 286-92.
A summary is given of the papers presented in this section of the symposium. The subject material is discussed under the headings:- (1) radiation of the quiet sun (2) the slowly varying component (3) the radio bursts and (4) the structure of the outer corona.
R.D.Davies

15539 EFFECT OF AN INCREASE OF RADIOWAVE CONTINUUM EMISSION ON THE EMISSION OF SOLAR TYPE I BURSTS. A.Boischot and P.Simon.
Ann. Astrophys. (France), Vol. 23, No. 6, 1006-9 (1960).
In French.
Among the Nançay records of solar radio emission at 169 Mc/s, some show a clear relation between continuum emission following flares and characteristics of noise storms. In those cases, the increase of continuum emission is accompanied by a decrease of the number and intensity of type I bursts.

15540 A STUDY OF 169 Mc/s THERMAL RADIATION FROM SOLAR ACTIVE SPOTS.
M.Moutot and A.Boischot.
Ann.Astrophys. (France), Vol. 24, No. 2, 171-9 (1961). In French.

The 169 Mc/s Nancay interferometer was used to study the slowly varying component to thermal emission of coronal condensations. The centres of emission have an average altitude of 150 000 km above the photosphere, and their diameters, much larger than on higher frequencies, lie between 10 and 20 minutes of arc. An important characteristic of these emissions is their directivity. No one centre has been observed at distances greater than 10 minutes of arc from the central meridian. Brightness temperature of the centres is around 1.2×10^6 °K, and this can be taken as coronal temperature at 0.2 R. above the photosphere.

15541 SCINTILLATION OF 169 Mc/s SOLAR RADIATION.
Y.Avignon.
Ann. Astrophys. (France), Vol. 24, No. 2, 168-70 (1961).
In French.

Solar observations made with the large interferometer at Nancay disclosed an abnormal scintillation phenomenon. This angular scintillation is of large amplitude, as great as 7.5 minutes of arc, and generally lasts for several minutes. It only exists when the sun is close to the horizon.

15542 EVOLUTION OF SOLAR RADIO-WAVE EMISSIONS OF TYPE IV AND THEIR RELATIONSHIP WITH OTHER SOLAR AND GEOPHYSICAL PHENOMENA. M.Pick-Gutmann.
Ann. Astrophys. (France), Vol. 24, No. 3, 183-210 (1961). In French.

A type IV burst is shown to be accompanied in general by an important burst in the centimetre-wave range. Two phases in the evolution of the radiation are distinguished, and the principal properties of each phase: directivity, polarization, and variability, are studied. It was noticed that in some cases the second phase was intense and of exceptionally long duration. These phenomena, or "continuum-storms" have a set of characteristic properties. The properties of centres of activity associated with type IV bursts are considered, and finally the relation which exists between the type IV bursts and the emissions of cosmic rays observed in the neighbourhood of the earth is shown. In conclusion, some theoretical interpretations are discussed.

15543 INTERFEROMETRIC STUDIES OF TYPE IV SOLAR BURSTS OF CONTINUUM RADIATION ON 340 AND 87 Mc/s. M.R.Kundu and J.W.Firor.
Astrophys. J. (USA), Vol. 134, No. 2, 389-93 (Sept., 1961).

Interferometric observations made on 340 and 87 Mc/s show the following properties of Type IV continuum bursts: (1) Type IV emission on 340 Mc/s occurs at a height of less than 40 000 km in the solar atmosphere. Its source has a small angular diameter (usually less than 4'), and it shows practically no motion within ±2 min of arc. (2) Type IV emission on 87 Mc/s occurs high in the corona (more than 200 000 km above the photosphere). Its source has a large angular diameter (of the order of 10' or larger) and a large movement. These distinctive properties of Type IV emission as observed on 340 and 87 Mc/s support the suggestion that Type IV emission occurs in two distinct phases — one characteristic of cm-wave continuum emission extending up to frequencies as low as 250 Mc/s, and the other characteristic of metre-wave continuum emission occurring at frequencies lower than about 250 Mc/s.

15544 SPECTRA OF SOLAR RADIO TYPE IV BURSTS.
T.Takakura and K.Kai.
Publ. Astron. Soc. Japan, Vol. 13, No. 1, 94-107 (1961).

Dynamic spectra of intense long-duration outbursts were studied in the frequency range of 9400 Mc/s to 67 Mc/s by using single-frequency records. There were at least two distinctive groups of outbursts. One was a long-duration outburst on centimetre waves (group A) and the other was believed to be type IV burst on metre waves (group B). These groups either occurred with a clear gap in the frequency range or accompanied another group on decimetre waves (group A–B). The type IV bursts on metre waves were frequently followed, after 30-60 minutes, by similar but longer and weaker radiations (group C). The bandwidths of individual groups except group A were rather narrow so that the energy of electrons emitting synchrotron radiation was estimated, assuming quasi-circular orbits, to be of the order of 10^5 eV. It is shown that group A is not a high-frequency component of group B, but groups A and B are radiated from two separate sources with different physical properties. It is suggested to call group A (centimetre wave type IV", group A–B "decimetre wave type IV" group B "metre wave type IV" and group C "metre wave post-typ IV".

15545 OBSERVATIONS OF 26.3 Mc/s SOLAR RADIO NOISE DURING AUGUST 1959. W.C.Erickson.
J. geophys. Res. (USA), Vol. 66, No. 6, 1773-80 (June, 1961).

These data displayed several characteristics not apparent in the observations at shorter wavelengths. First decametre wave length emission was observed before the metre wavelength emission. Second, intense decametre wave emission ended on August 25, whereas intense metre wavelength emission persiste until September 3. Third, observations indicate quite uniform emission. The intense amplitude scintillations found by other observers were not observed. Observations tend to confirm the identification of this disturbance as a type I noise storm. Even decameter wavelengths, the emission region appeared to be of small angular diameter, and low in the corona.

15546 DISTRIBUTION OF ORIGIN AND DECAY OF NOISE STORMS ON THE SOLAR DISK. P.Maltby.
Astrophys. Norveg. (Norway), Vol. 6, No. 13, 147-60 (Aug., 1960

It is found that noise storms tend to originate on the easter half of the solar disk, while more noise storms decay on the western half. The analysis is based on the interferometer data from the Nera station of the Netherlands PTT and radiometer observations at the Solar Observatory, Harestua. An attempt made to explain the observed asymmetry in start and decay in terms of the limiting iso-diaphanous surface and the angular emission diagram of the radio source. An asymmetry in the observed distribution of noise storms on the solar disk indicate that the angular emission diagram of the radio source is not perpendicular to the surface of the sun.

15547 SOME STATISTICS OF SOLAR RADIO BURSTS AT SUNSPOT MAXIMUM.
A.Maxwell, W.E.Howard, III and G.Garmire.
J. geophys. Res. (USA), Vol. 65, No. 11, 3581-8 (Nov., 1960).

Discusses the occurrence and intensity of solar radio burst at four frequencies in the band 100 to 600 Mc/s. The observatio cover 4010 hr during a 12-month period at sunspot maximum; th results refer essentially to bursts of intensity great than 10^{-21} m.k.s. unit and duration greater than 0.3 sec; and the statistical information is interpreted in terms of the spectral characteristics of the bursts. The experimental data were take at Fort Davis, Texas, and the analysis shows that at 125 Mc/s burst radiation was recorded for 560 hr of which 380 hr were of low intensity. At 200 Mc/s the burst radiation covered 350 hr, which 240 hr were of low intensity. For these two frequencies t bursts occurred mainly in the form of noise storms (spectral type I). At 425 and 550 Mc/s the total times of the solar bursts were much less, being respectively 21 and 23 hrs; for the most part, however, this radiation was of high intensity and appeared in the form of continuum radiation (spectral type IV) over a wid frequency range.

15548 ON THE CONNECTION BETWEEN SOLAR NOISE STORMS AND OBSERVABLE PARAMETERS OF SUNSPOTS. P.Maltby and O.Steen.
Astrophys. Norveg. (Norway), Vol. 7, No. 1, 1-11 (Oct., 1960).

Several properties of sunspots are tested as indicators of r noise activity. A pronounced connection is found between the darkness of the umbra and noise storms. No genuine unipolar spot showing noise action is found in the present material. The investigation is based on the optical data from the Mt. Wilson Observatory and the Crimean Astrophysical Observatory. Inter ferometer and radiometer data are from the station Nera of the Netherlands PTT and the Solar Observatory at Harestua.

15549 VERY-LOW-FREQUENCY MODULATION OF DISCRETE FREQUENCY SOLAR NOISE BURSTS.
J.Aarons, S.Basu, W.Kidd and R.Allen.
Nature (GB), Vol. 191, 56-7 (July 1, 1961).

Records of solar bursts at 220, 400 and 3000 Mc/s are analysed to give the power spectra of the noise envelope. In som cases, narrow-band structure is found, indicating modulation at frequencies of about 300 c/s. H.Rish

550 SOLAR EMISSION AT TEN CENTIMETRE WAVE-LENGTH, 1947-1960. A.E.Covington.
y. Astron. Soc. Canada, Vol. 55, No. 4, 167-72 (Aug., 1961).
Three graphical representations involving the 10.7 cm solar tion for a period somewhat greater than a sun-spot cycle are ented. The first parameter is a pair of numbers giving the st and the lowest values of daily flux for each month, the nd parameter is the monthly mean of the daily flux, and the is a monthly count of the number of bursts in various intensity vals.

5551 STUDY OF SOLAR FLARES USING COSMIC RADIO NOISE ON 25 Mc/s AT AHMEDABAD (23°02' N,72°38' E).
Bhonsle.
. Indian Acad. Sci. A, Vol. 51, No. 4, 189-201 (April, 1960).
Describes observations of sudden cosmic noise absorptions 'A's) associated with solar flares. The frequency distributions lar flare attenuations, their times of growth and duration, etc., determined and the results are compared with those of other ers. The SCNA's on 25 Mc/s recorded at Ahmedabad in -58 were markedly larger in size and duration than those rved in Australia on 18·3 Mc/s in 1950-51.

15552 SYNCHROTRON RADIATION FROM INTERMEDIATE ENERGY ELECTRONS AND SOLAR RADIO OUT-STS AT MICROWAVE FREQUENCIES. T.Takakura.
l. Astron. Soc. Japan, Vol. 12, No. 3, 325-51 (1960).
The emissivity, absorption coefficient, polarization, and dura- for synchrotron radiation of electrons with velocities 0.25 to) of the velocity of light are treated in this paper. Self-absorp- is comparatively strong owing to the high emissivity, so that ietimes re-absorption must be taken into account in computing radiation flux. It is pointed out that the characteristics and eration mechanism of solar radio outbursts are distinctly differ- at frequencies below and above a certain cross-over frequency ch is somewhere between 400 Mc/s and 1000 Mc/s. An attempt nade to account for the characteristics of outbursts above the ss-over frequency by synchrotron radiation from electrons n intermediate energy. Type IV bursts probably fall into the ie category as the outbursts above the cross-over frequency. power spectrum derived from the radiation of electrons with ower-law electron-energy spectrum is consistent with the erved average spectrum of outbursts at microwave frequencies. as been observed in Japan that outbursts at 1000, 2000, 3750 and 0 Mc/s had a circularly polarized component of 10 to 100%; in eral, the sense of rotation reversed somewhere between 2000 . 3750 Mc/s. This behaviour can be expected from synchrotron iation because the frequency of the fundamental component of chrotron radiation is below the gyro-frequency of the surround- thermal electrons. Consequently, the extraordinary component not escape, as expected from the magneto-ionic theory. However, radiation from the relativistic electrons contains both an raordinary and a weaker ordinary component. The ordinary nponent can escape without serious absorption so that the sense rotation of the escaping wave whose frequencies are below the o-frequency is ordinary. On the other hand, the radiation at quencies above the gyro-frequency can escape without strong orption. Then the sense of rotation is that of an extraordinary ve. The characteristics of outbursts at frequencies below the ss-over frequency seem difficult to be explained by the synchro- n radiation and are probably caused by another mechanism ated to plasma oscillations.

15553 SYNCHROTRON RADIATION FROM INTERMEDIATE ENERGY ELECTRONS IN HELICAL ORBITS AND LAR RADIO BURSTS AT MICROWAVE FREQUENCIES.
Takakura.
bl. Astron. Soc. Japan, Vol. 12, No. 3, 352-75 (1960).
The emissivity, absorption coefficient, polarization and ectrum for synchrotron radiation of electrons in helical orbits h velocities 0.25 to 0.9 of the velocity of light are treated in s paper. The general tendency is similar to a case in which bits of electrons are circular (see preceding abstract). A major ference is a remarkable increase in the radiation at frequencies ow the gyro-frequency, f_0, of ambient thermal electrons. At quencies below f_0, only the ordinary component can escape ough the solar atmosphere, as mentioned in the preceding paper. e ordinary component was very small in the preceding paper, and ce a decrease in flux density at frequencies below f_0 was large. however, orbits of electrons are helical, the ordinary component frequencies below f_0 is much greater, as is shown in the present paper, so that the decrease in flux density is smaller. The theoretical result is compared with observed spectra and polarizations of bursts at microwave frequencies. An average profile for the observed spectra reveals a decrease in flux density at the frequencies below a certain frequency at which the sense of circular polarization reverses. This frequency for the sense-reversal seems to be f_0. Therefore, the decrease in flux density at the frequencies below f_0 is consistent with the theoretical result. Furthermore, the average profile is very similar to a profile which is derived theoretically under some special assumptions but may show an average profile. The bursts at microwave frequencies are probably caused by the synchrotron radiation from intermediate-energy electrons, gyrating in helical orbits (or circular orbits) generally in strong magnetic fields near the sunspots.
pots.

15554 ON THE EXCITERS OF TYPE II AND TYPE III SOLAR RADIO BURSTS. Y.Uchida
Publ. Astron. Soc. Japan, Vol. 12, No. 3, 376-97 (1960).
The exciters of transient solar radio emission—the type II and type III bursts in the nomenclature by Wild et al. (Abstr. 2328-9 of 1950) — are discussed from the viewpoint of the velocity with which their sources move in the solar atmosphere. Several possible types of motion in the physical condition above a sunspot are considered in order to account for the observed velocity and its variation with height of each type of burst. Propagation of ordinary and hydromagnetic shocks, with the dissipation of energy through irreversible changes at the front being taken into account, in a usual model solar atmosphere with a model sunspot field are treated. It is concluded that the front velocity of a hydromagnetic shock, which is assumed to be caused by an initial disturbance like a flare-surge, can be considered as the exciter of the type II burst. The only possible agency responsible for the velocity of the type III bursts seems to be the streaming motion of individual particles along the magnetic lines of force, or in a region free from it. Attribution of the exciter velocities of type II and type III bursts to those of the hydromagnetic shock-front and the free streaming motion of particles respectively, also explains some other features of the observed facts.

15555 RADAR-LUNAR INVESTIGATIONS AT A LOW GEOMAGNETIC LATITUDE.
G.H.Millman, A.E.Sanders and R.A.Mather.
J. geophys. Res. (USA), Vol. 65, No. 9, 2619-26 (Sept., 1960).
Radar reflections from the moon were studied utilizing the Trinidad, BWI, radar operating in the 400 Mc/s frequency range. The moon was tracked from moonrise through transit during periods of sunset. On all occasions, the rotation of the plane of polarization (Faraday effect) was observed. Absolute values of the total electron content of the ionosphere deduced from these measurements and the electron content above the height of the F-layer maximum, evaluated from vertical-incidence ionospheric soundings recorded at the NBS Puerto Rican station, are presented.

15556 EVIDENCE THAT THE MOON IS A ROUGH SCATTERER AT RADIO FREQUENCIES.
R.L.Leadabrand, R.B.Dyce, A.Fredriksen, R.I.Presnell and J.C.Schlobohm.
J. geophys. Res. (USA), Vol. 65, No. 10, 3071-8 (Oct., 1960).
Radar echoes from the moon were observed at 400 Mc/s for the purpose of determining the scattering properties of the moon. The results go beyond the investigations of other authors who claim that the moon is a quasi-smooth reflector having a range depth of less than 600 μsec. Results described in this report indicate that, although the moon behaves as a quasi-smooth reflector in the 0 to 600 μsec range depth, beyond this range the moon behaves as a uniformly rough scatterer, giving echoes out to 1 lunar radius or the limit of visibility of the moon's surface from the earth. An empirical fit to the integrated range versus time display provides an angular scattering law for each infinitesimal area of the surface given by:

$$P(\phi) \propto [(\sin \theta)/\theta]^{20\pm6} + 1/10$$

A procedure for mapping the details of the moon's surface by radar, using range and Doppler shift coordinates, is suggested. This technique does not require angular resolution.

RADAR REFLECTIONS FROM THE MOON. See Abstr. 16576

15557 A THEORY OF RADAR REFLECTION FROM THE MOON AND PLANETS. F.B.Daniels.
J. geophys. Res. (USA), Vol. 66, No. 6, 1781-8 (June, 1961).

Huygens' principle is used to derive relations between the surface statistics of a randomly irregular celestial radar target and the angular power spectrum and autocorrelation function of the reflected signal. The spatial correlation function of the signal observed by spaced receivers is also computed. From observed lunar signal fading data a crude pictorial representation of the small-scale structure of the moon's surface is constructed. The angular power spectrum is derived from the autocorrelation function of the signal fading, and the result is compared with the angular distribution measured directly by means of the pulse-delay technique.

15558 SOME PROPERTIES OF RADIO WAVES REFLECTED FROM THE MOON AND THEIR RELATION TO THE LUNAR SURFACE. T.Hagfors.
J. geophys. Res. (USA), Vol. 66, No. 3, 777-85 (March, 1961).

Presents a theoretical discussion of the statistical properties of radio-waves reflected from the moon. The discussion is based on the assumption of a large number of scattering areas simultaneously contributing to the signal. The properties of the echoes are usually described in terms of pulse broadening or by means of an average-power pulse response when very short pulses are transmitted. Here it is shown that the same type of information can be obtained by studying the correlation of complex amplitudes of two sine waves reflected from the moon at frequencies separated by $\Delta\omega$. By studying this correlation as a function of $\Delta\omega$ it is possible to compute the power pulse response of the earth–moon–earth propagation circuit. It is suggested that this method will prove particularly useful in the study of the surface properties of more distant targets such as the planets. It is also shown how the correlation technique can be extended to a two-dimensional mapping of a rotating rough body. The properties of the echoes returned from the moon are related here to a crude statistical model of the lunar surface roughness. This model is shown to lead to a satisfactory account for the semispecular component of the return from the moon if a large-scale structure with r.m.s. slopes of 1/20 to 1/10 are assumed.

15559 A LUNAR AND PLANETARY ECHO THEORY. W.E.Brown, Jr.
J. geophys. Res. (USA), Vol. 65, No. 10, 3087-95 (Oct., 1960).

The lunar radar echo is divided into specular and Lambert scatter components, the specular component being derived from a statistical model of the lunar surface. The theoretical impulse response is compared with experimental data from Trexler (Abstr. 1448 of 1958) and the theoretical frequency response is compared with some preliminary Goldstone moonbounce experimental data. The theory indicates that the Lambert component will be visible at high power levels and would probably become apparent about 1000 μsec after the leading edge of the echo. A value for reflectivity of 0.01 found from the level of the scatter component is used to derive an estimate of some of the average properties of the lunar surface.

15560 EXPLORATION OF VENUS BY RADAR. W.K.Victor and R.Stevens.
Science (USA), Vol. 134, 46-8 (July 7, 1961).

On 10 May 1961 a radar signal was beamed at the planet Venus, and for the first time in history the return echo was detected within a few minutes. A new value for the Astronomical Unit has been determined. The data indicate that Venus rotates slowly and that it is a better radio reflector than the moon.

15561 INTERFEROMETRIC MEASUREMENTS ON THE RADIOSOURCE HERCULES A AT 1420 Mc/s. J.Heidmann and J.Lequeux.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 226-7 (July 10, 1961).
In French.

15562 AN INVESTIGATION OF THE CLUSTERING OF RADIO STARS. P.R.R.Leslie.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 5, 371-80 (1961).

An examination was made of the results of two recent surveys of radio sources at Cambridge (England), in order to investigate the clustering of sources. Two methods of analysis were used, which allowed the study of associations of sources haven angular separations in the range 3'·5 to 200' arc. No evidence for clustering was found, and over most of this range an upper limit of about 10% could be set to the percentage of sources which occur in clusters. During the observations a number of intense sources, hitherto believed to be extended, w found to be close double or multiple systems; they represent a small fraction of the total, however, and the number found is not inconsistent with the upper limits of clustering which were derived.

15563 GALACTIC EXPLOSIONS AS SOURCES OF RADIO EMISSION. G.R.Burbidge.
Nature (GB), Vol. 190, 1053-6 (June 17, 1961).

Many strong radio sources can be identified with elliptic galaxies. It is suggested that radio emission from such galaxi arises from supernovae explosions, one explosion setting off a chain reaction of stellar explosions under suitable conditions. possibility of such a mechanism is investigated, and it is conc that strong radio sources will be produced in comparatively o galaxies in which the star density is high. The various stages development of an exploding galaxy are described and some ide radio sources are classified in an evolutionary sequence on th basis of the proposed model. R.A.

15564 THE NUMBER–FLUX DENSITY RELATION FOR RADIO SOURCES AWAY FROM THE GALAC PLANE. P.F.Scott and M.Ryle.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 5, 389-97 (1961).

Two new series of observations at a frequency of 178 Mc/ were combined to derive the number–flux density (N–S) rela for radio sources situated at galactic latitudes $> 20^0$. In orde to investigate the possible errors which might be introduced b various instrumental selection effects, detailed investigations made both of the distribution in "surface brightness" of the sources, and of the extent to which radio sources occur in clu It is shown that neither effect introduces an important error the observed number–flux density relation. The observations when corrected for these effects, provide a plot of $\log N$ again $\log S$ which, over the range $100 > S > 2 \times 10^{-26} W(c/s)^{-1} m^{-2}$, may be approximated by a straight line of slope $-1{\cdot}80$. If acc is taken of the errors in the observations and uncertainties in analysis it is concluded that the slope lies in the range $-1{\cdot}68$ to $-1{\cdot}93$.

15565 THE FIRST DISCOVERY OF POINT SOURCES [INTRODUCTORY LECTURE TO PART III - GAL AND EXTRAGALACTIC RADIO SOURCES]. J.S.Hey.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 o 1960) p. 295-6.

Tests were made to see if cosmic noise was responsible reducing the performance of operational radar sets, during wh a fluctuating source of radio emission was found in Cygnus. small angular size of the source was only definitely establish interferometer measurements by Bolton and Stanley. This le the discovery of large numbers of discrete radio sources. R.D.

15566 THE SPECTRA OF THE RADIO SOURCES. G.R.Whitfield.
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 o 1960) p. 297-304.

Spectra for 85 radio sources have been obtained. The sp of Cassiopeia-A has a constant index whereas Cygnus-A has a index which increases at the higher frequencies. It is found t galactic sources have a spectral index of approximately -0.6, tified extra-galactic sources have an index of -0.9 and uniden extra-galactic sources have an index of -1.2. R.D.

15567 POLARIZATION OF 10 cm RADIATION FROM TH CRAB NEBULA. A.D.Kuz'min and V.A.Udal'tsov
Radio Astronomy Symposium, Paris, 1958 (see Abstr. 10477 o 1960) p. 305-8.

A polarimeter at a frequency near 3100 Mc/s was used in conjunction with the 31 m radiotelescope. The radiation fr the Crab Nebula was linearly polarized 3 ± 0.5 % at a positio angle of 142 ± 5^0. R.D.

15568 ON THE RADIO EMISSION FROM H II CLOUDS. F.Moriyama.
Publ. Astron. Soc. Japan, Vol. 12, No. 2, 203-13 (1960).

The radio emission from H II clouds is investigated with

ıl regards for the relation to the nature of exciting stars. An ot is made to explain the radio observations in terms of ble optical data, and Westerhout's identification is confirmed number of radio sources. The intense radio radiation from 3618 is discussed in comparison with the observed Hα in- y. The space density of O-type stars is estimated from radio and compared with an optical estimate.

5569 LUNAR OCCULTATION OF A RADIO SOURCE. C.Hazard.
e (GB), Vol. 191, 58 (July 1, 1961).
'he position of a radio source was determined to within 5" of arc. H.Rishbeth

5570 COSMIC NOISE MEASUREMENTS FROM 1960 η1 at 3.8 Mc/s. A.R.Molozzi, C.A.Franklin and J.P.I.Tyas.
'e (GB), Vol. 190, 616-17 (May 13, 1961).
A solid-state radiometer carried in satellite Transit IIA having tre frequency of 3.8 Mc/s measured cosmic noise above the phere. Some details are given of the calibration of the equip- , and of results obtained. G.M.Brown

ıce Research

5571 SPACE-FLIGHT AND RE-ENTRY TRAJECTORIES. D.G.King-Hele.
'e (GB), Vol. 191, 960 (Sept. 2, 1961).
A report of a symposium, organized by the International emy of Astronautics, which was held at Louveciennes near s during June 19-21, 1961. There were four sessions under the wing titles: Trajectories for Lunar and Interplanetary ions; Orbital Transfer and Rendezvous; New Earth Satellites; Dynamics of Terminal Re-entry.

5572 THE THEORY OF ARTIFICIAL SATELLITES IN TERMS OF THE ORBITAL TRUE LONGITUDE. ısen.
ophys. Res. (USA), Vol. 66, No. 2, 403-9 (Feb., 1961).
The author's previous theory of the artificial satellite (Abstr. 7 of 1960) is derived in terms of the disturbed eccentric ıaly. The present development, in terms of the orbital true tude, is a substantial improvement over the earlier work in it leads to the faster convergence for large eccentricities and smaller number of terms in the series representing the ırbations. Moreover, each approximation of the radius vector of the parameters determining the position of the orbit plane tained not in the form of a truncated infinite series but in the ı of trigonometric polynomials in two arguments. These ments are the mean true anomaly and the mean argument of atitude. The present theory, like the previous one, permits computation of perturbations of any desired order. Thus, any 'e information about earth's gravitational field can easily be ıded.

5573 COMPUTATION OF COORDINATES FROM BROUWER'S SOLUTION OF THE ARTIFICIAL ELLITE PROBLEM. O.K.Smith.
on. J. (USA), Vol. 66, No. 7, 359 et seq. (Sept., 1961).
The method developed by Brouwer (Abstr. 6632 of 1960) for puting rectangular coordinates of an artificial satellite is ified so as to avoid low eccentricity and low inclination ularities. Only minor changes in the calculation of the elements required, consequently it should not be difficult to incorporate e results into an existing machine programme based upon ıwer's expressions. The equations given here have been rammed and tested on an IBM 7090.

5574 SATELLITE ORBIT PERTURBATIONS IN VECTOR FORM. R.R.Allan.
re (GB), Vol. 190, 615 (May 13, 1961).
A note showing how the first-order perturbation theory of lite orbits can be formulated in terms of constants of the rturbed motion using vector methods. G.M.Brown

5575 EFFECT OF AN OBLATE ROTATING ATMOSPHERE ON THE ORIENTATION OF A SATELLITE ORBIT. Cook.
. Roy. Soc. A (GB), Vol. 261, 246-58 (April 25, 1961).
For an earth satellite orbit of small eccentricity ($e < 0.2$) formulae are derived for the changes per revolution produced by the atmosphere in the argument of perigee, in the right ascension of the ascending node, and in the orbital inclination. These changes are then expressed in terms of the change in length of the semi-major axis, and numerical values are obtained for satellite 1957 β. It is found that the rotation of the major axis in the orbital plane due to the atmosphere is significant, being most important for inclinations between 60 and 70°. The total rotation, due both to the gravitational potential and to the atmosphere, agrees reasonably well with the observed values. The oblateness of the atmosphere is found to have only a small effect on the changes in the orbital inclination and the right ascension of the ascending node.

15576 ON THE MOTION OF A SATELLITE IN AN ASYMMETRICAL GRAVITATIONAL FIELD. P.Musen.
J. geophys. Res. (USA), Vol. 65, No. 9, 2783-92 (Sept., 1960).
Existing satellite data have a tracking precision and a limited interval of observation sufficient only for the determination of the zonal harmonics in the geoid. With the availability of more accurate data, extended over longer intervals of time, it will also become possible to determine the tesseral harmonics in the gravitational field. The present theory, developed in anticipation of the availability of these data, extends the work published by the author recently to permit the easy inclusion of the influence of tesseral harmonics, and consequently also of gravitational anomalies, in the motion of an artificial satellite.

15577 ON THE LONG-PERIOD LUNISOLAR EFFECT IN THE MOTION OF THE ARTIFICIAL SATELLITE. P.Musen.
J. geophys. Res. (USA), Vol. 66, No. 6, 1659-65 (June, 1961).
This article contains two systems of formulae for the determination of the long-period perturbations caused by the sun and the moon in the motion of an artificial satellite. The first system can be used for the determination of the lunar effect for all satellites. The second method is more convenient for finding the lunar effect for close satellites and the solar effect for all satellites. The knowledge of these effects is essential for the determination of the stability of the orbit of the satellite. The basic equations of both systems are arranged in a form that permits the use of numerical integration. The two theories are more accurate and more adaptable to the use of electronic machines than are the analytical developments obtained previously.

15578 NUCLEAR ENERGY IN SPACE.
Nucleonics (USA), Vol. 19, No. 4, 53-100 (April, 1961).
A "Nucleonics" special report consisting of a series of articles on the application of nuclear power to rocket propulsion and auxiliary power generation. Subjects covered include the U.S.A. development programme, a comparison of the potentialities of nuclear-powered and chemical-powered rockets, the requirements of nuclear safety including a possible increase in background radioactivity due to burn-up in the atmosphere on re-entry, nuclear electric power sources for auxiliary units, rocket engines and control systems, including advanced concepts such as gaseous phase reactors or nuclear explosion propulsion units, materials of construction and the effects of the space environment including radiation, meteoroid hazards, effects of ultra-high vacuum and thermal effects. See also following three abstracts. R.D.Smith

15579 RADIONUCLIDE POWER FOR SPACE MISSIONS. D.G.Harvey and J.G.Morse.
Nucleonics (USA), Vol. 19, No. 4, 69-72 (April, 1961).
Suitable radionuclides are tabulated together with the characteristics of four thermoelectric generators SNAP 3, SNAP 9, SLLG and SNAP 1A. These are fuelled with Po^{210}, Pu^{238}, Cm^{242} and Ce^{144} and generate 3, 14, 19 and 125 W respectively. Present generators use lead telluride junctions but other materials capable of higher temperature operation and also thermionic generators are being developed. R.D.Smith

15580 COMPACT REACTORS FOR SPACE POWER. H.M.Dieckamp, R.Balent and J.R.Wetch.
Nucleonics (USA), Vol. 19, No. 4, 73-6 (April, 1961).
Reactors designed to operate in space must be reliable, have low weight and operate at high temperatures, so as to minimize radiator size. The systems at present contemplated have fully enriched uranium fuel dispersed in zirconium hydride moderator with beryllium reflectors. For powers below 1 kW thermoelectric devices can be used; at higher powers turbines using Hg, Rb, or K as a working fluid will be needed. R.D.Smith

15581 GASEOUS PROPULSION REACTORS.
R.V.Meghreblian.
Nucleonics (USA), Vol. 19, No. 4, 95-9 (April, 1961).

The performance of a reactor in which a region is non-temperature limited (i.e. gaseous fuel) is studied in general terms. The maximum specific impulse ratio is first, calculated and found to be limited by the fraction of fission power appearing as gamma energy since this heats the solid region of the reactor. This limit can only be raised at the expense of adding a radiator to cool the solid part of the reactor. The performance of a typical gas-phase propulsion reactor is analysed and possible methods for gas-phase separation of fuel and propellant are described. R.D.Smith

15582 SCATTERING SHIELDS FOR [NUCLEAR] SPACE POWER. C.N.Klahr.
Nucleonics (USA), Vol. 19, No. 4, 110, 112 (April, 1961).

Design of shields for use in space differs from conventional design because of the absence of back-scatter, the need to minimize the weight and the low heat-loss. By dividing shields into a number of sections of appropriate geometry, radiation scattered in the shield may be lost to space and build-up reduced. It is also important to ensure that radiation that would otherwise not reach the detector is not scattered to the detector by the shield itself. R.D.Smith

15583 AN INSTRUMENT FOR THE INVESTIGATION OF INTERPLANETARY PLASMA.
H.S.Bridge, C.Dilworth, B.Rossi, F.Scherb and E.F.Lyon.
J. geophys. Res. (USA), Vol. 65, No. 10, 3053-5 (Oct., 1960).

The instrument is designed to determine the density, direction, and magnitude of the bulk velocity of the protons of the interplanetary plasma. It is essentially a Faraday cup containing four grids which serve (a) to keep the electrons of the plasma from reaching the collector and (b) to suppress the photoelectric current by modulating the incoming protons without modulating the photoelectrons produced when the cup faces the sun. A transistoris electronic system amplifiers, compresses, and demodulates t a.c. signal from the collector before transmitting it to the tel system of the vehicle. Current densities from 10^{-12} to 10^{-8} A and proton kinetic energies from 10 to 3000 eV, can be measu

15584 UPPER ATMOSPHERE AND SPACE EXPLORATI WITH ARTIFICIAL SATELLITES. S.K.Mitra.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 215-32 (May 26,

Anniversary address at the general meeting of the Nation Institute of Sciences of India in Bombay on Jan. 2, 1960. A general review is given, and India's participation in space res is briefly discussed.

15585 BEHAVIOUR OF UNPERTURBED SYSTEMS IN A INERTIAL SPACE. V.A.Bodner and V.P.Selezne
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1043-6 (June 11, 196
In Russian.

Some properties of unperturbed navigational satellite sys with auto-compensating channels (for gravitational acceleratio are studied. It is found that (1) the autocompensation of gravi accelerations in all three channels of the inertial system is governed by the characteristic equation $(p^2 + g/R)^2(p^2 - 2g/R)$ where p is the differential operator, g = acceleration due to g R = distance of satellite from the centre of the system, i.e. su (2) the period of the error fluctuation is equal to the period of satellite in the orbit of radius R, moving with velocity $V_1 = \sqrt{g}$ (3) the time constant of the error increase of the inertial syst equal to the time constant of the satellite when moving off fro equivalent centre with velocity $V_2 = \sqrt{2gR}$. [English translatio Soviet Physics—Doklady (USA)]. J.K.Skwir

RADIO SIGNALS FROM SATELLITES BELOW THE HORI
See Abstr. 16582

PHYSICS

GENERAL

15586 ABRAM FEDOROVICH IOFFE.
Kristallografiya (USSR), Vol. 5, No. 5, 671-3 (Sept.-Oct., 1960). In Russian.

Academician Abram Fedorovich Ioffe, one of the most prominent Soviet physicists, died on October 14, 1960. This article gives a short account of his life and work. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 641-3 (March-April, 1961)].

15587 THE PIERRE S. du PONT SCIENCE BUILDING, SWARTHMORE COLLEGE. I.E.Dayton.
Amer. J. Phys. Vol. 29, No. 11, 753-63 (Nov., 1961).

The building was completed in the late autumn of 1959 and houses the departments of physics, chemistry and mathematics as well as the science library. It comprises four distinct but interconnected units arranged around a central landscaped courtyard. The interior arrangement of the entire building is described and features of interest to physicists are pointed out. Particular attention is paid to the procedure followed in planning the building.

15588 PHYSICS EDUCATION IN POLAND.
A.Piekara.
Amer. J. Phys., Vol. 29, No. 11, 764-6 (Nov., 1961).

The basic system of education in Poland is described, followed by a discussion of the education in physics offered there.

15589 PHYSICS FOR THE BIOLOGIST.
O.Blüh.
Amer. J. Phys., Vol. 29, No. 11, 771-6 (Nov., 1961).

The work of college physics teachers is to a great extent devoted to the teaching of service courses for non-physics students, engineering students probably forming the largest group. Little provision is made for students in the biological sciences beyond the introductory physics course. With the growing recognition of the importance of physics in biology and medicine, and the advent biophysics, it can be excepted that physics departments will s called upon to organize advanced physics courses for biologis This paper discusses the past and present situation, and outli two physics courses for biologists offered at different levels: intermediate course and a biophysics course. Out of these ne physics service courses for the biology, premedical and medi students, and others, valuable experience will be gained about teaching programmes for biophysicists.

15590 LABORATORY PERFORMANCE TESTING.
G.R.Caughlan and G.C.Towe.
Amer. J. Phys., Vol. 29, No. 11, 777-9 (Nov., 1961).

The nature of the laboratory performance testing progra introduced at Montana State College in 1959 is described. Six original test problems are discussed. Analysis of the testing reveals benefits to students and instructors such as improven of regular laboratory work, a more realistic basis for gradin the possibility of discovering instruction deficiencies.

15591 PAULI AND NUCLEAR SPIN.
S.A.Goudsmit.
Phys. Today (USA), Vol. 14, No. 6, 18-21 (June, 1961).

Historical review.

15592 ON CARNOT'S PRINCIPLE AS GENERALIZED B BRILLOUIN IN ITS APPLICATION TO THE PRE OF MEASURING APPARATUS. J.Oudin.
C.R. Acad. Sci. (France), Vol. 252, No. 20, 3008-10 (May 15,
In French.

If two systems are brought together, the entropy in gener increases. According to Brillouin's principle, the informatio gained cannot exceed this gain of entropy. The "lost informa corresponds to the change in entropy of the measuring appara For the experiment to be "efficient" this must be small comp with the information gained — there must be little uncertaint about the "states" of the measuring apparatus.

H.N.V.Ten

5593 CAUSALITY AND THE KRAMERS—KRONIG RELATIONS. N.G.Van Kampen.
ays. Radium (France), Vol. 22, No. 3, 179-91 (March, 1961).
ench.
Taking examples from various fields of physics (elasticity, y of oscillations, optics, etc.) it is shown that the Kramers— ig relations between real and imaginary parts of the refractive (or analogous quantity) are a consequence of the principle of ality, i.e. the principle that the effect cannot take place before ause. Then this principle is applied to microscopic physics, ig relations between the real and imaginary parts of the ele- s of the S-matrix. The scattering of a classical electromagnetic and of Schrödinger particles are discussed, and the method eby the principle can be generalized to the scattering of quantum s is given.

GRAVITATION . RELATIVITY

5594 L.EULER, THE PRINCIPLE OF RELATIVITY AND THE FUNDAMENTALS OF CLASSICAL MECHANICS. peiser.
ure (GB), Vol. 190, 757-9 (May 27, 1961).
Attention is drawn to the significance of Euler's derivation of rration formulae in early discussions of absolute space and time of the principle of relativity. R.A.Newing

5595 COORDINATE CONDITIONS. J.Plebanski and J.Ryten.
nath. Phys. (USA), Vol. 2, No. 5, 677-81 (Sept.-Oct., 1961).
Some extremal properties of coordinates imposed by coordin- conditions are studied. In particular, variational principles ding to the de Donder condition, the generalized de Donder dition, $[(-g)^{w}g^{\alpha\beta}]_{|\beta} = 0$; Einstein's old condition $(-g)^{1/2} = 1$; the Einstein—Infeld conditions $[(-g)^{1/2}g^{\alpha\beta}]_{|\rho} = 0$, $[(-g)^{1/2}g^{ab}]_{|b} = 0$ given. The class of generalized de Donder conditions is mined in the case of Schwarzschild's solution. The values of $0, \frac{1}{2}, \frac{3}{4}, \frac{3}{4}, 1$ are here distinguished. For an arbitrary w the thematical problem is reduced to the study of certain solutions he hypergeometric equation.

15596 TRANSFORMATIONS OF THE INHOMOGENEOUS LORENTZ GROUP AND THE RELATIVISTIC EMATICS OF POLARIZED STATES. V.I.Ritus.
eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 352-64 (Jan., 1961). Russian.
Representations of the inhomogeneous Lorentz group are sidered which correspond to physical systems possessing mass, mentum, and intrinsic angular momentum, for which the polari- ion is described by values of the projection of the intrinsic ular momentum along a prescribed direction or of the total ular momentum along the direction of the momentum (the icity). Representations are also considered which correspond physical systems with zero mass, for which the polarization is scribed only by the projection of the total angular momentum ng the direction of the momentum. For these representations all the transformations of the inhomogeneous Lorentz group which ermine the relativistic kinematics of the polarization are found explicit form. The representations for systems with zero mass obtained from those for systems with mass $\kappa \neq 0$ by passage to limit $\kappa \to 0$. [English translation in: Soviet Physics—JETP SA), Vol. 13, No. 1, 240-8 (July, 1961)].

15597 RIEMANNIAN FOURFOLDS OF CLASS ONE AND GRAVITATION. K.P.Singh and S.N.Pandey.
oc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 661-73 (Nov. 26, 1960).
A general Riemannian fourfold of class one is considered as a turbance in a fourflat introduced through a function ψ of the ordinate variables x^1, x^2, x^3, x^4. The case when ψ is a function of e variable is trivial. If ψ is a function of two variables it is own that the gravitational situation is incompatible with perfect id distribution and with a distribution of electromagnetic radiation the vanishing of the scalar curvature R turns out to be a cessary and sufficient condition for space-time to be flat. The rvature tensor and the Ricci tensor are expressed for the neral case in terms of the metric potentials. Assuming spherical mmetry, the pressure and density are obtained in terms of ψ. As particular solution a new form of the line-element for Lemaitre's iverse is deduced from class one considerations.

15598 ON THE GRAVITATIONAL INSTABILITY IN FLATTENED SYSTEMS WITH AXIAL SYMMETRY AND NON-UNIFORM ROTATION. V.S.Safronov.
Ann. Astrophys. (France), Vol. 23, No. 6, 979-82 (1960).
The condition of gravitational instability for flat non-uniformly rotating systems is found on the basis of Bel and Schatzman's solution of the problem for cylindrical systems infinite along the axis of rotation. The disk is assumed of uniform density and constant thickness H rotating around central mass. The critical density in the equatorial plane of the disk with Keplerian rotation (solar system, outer parts of the Galaxy) is estimated. It is found that the critical density is minimal at a wavelength of perturbation $\lambda_m \cong 8$ H and is the higher the more λ differs from λ_m.

15599 SOME AXIALLY SYMMETRIC EMPTY GRAVITATIONAL FIELDS. M.Misra.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 673-80 (Nov. 26, 1960).
An axially symmetric gravitational field is considered in oblate spheroidal coordinates. It is well known that one of the field equations for empty space-time in case of axially symmetric gravitational fields is the Laplace equation. Three special solutions of the field equations $T^{\alpha}_{\beta} = 0$ are obtained. Considering the motion of test particles two of the solutions are identifiable as the relativistic analogues of the Newtonian field due to an oblate spheroidal homoeoid and the field due to a homogeneous oblate spheroid respectively. The equations of motion to the first order of approximation reduce to the well-known Newtonian form.

15600 ELECTROMAGNETIC AND GRAVITATIONAL INDUCTION. L.Bel.
Ann. Inst. Poincare (France), Vol. 17, No. 1, 37-57 (1961). In French.
The electromagnetic field in a moving medium is analysed, with a covariant formalism, in terms of the characteristic velocity of the medium and the 4-velocities of medium and observer. A similar analysis of the gravitational field yields "striking analogies", although the author admits that this part of the work contains arbitrary elements. F.A.E.Pirani

15601 ON THE THEORY OF GRAVITATIONAL RADIATION. P.Burcev.
Czech. J. Phys., Vol. 11, No. 6, 385-9 (1961). In Russian.
The equations of motion of weakly radiating particles are investigated in a linear approximation in which the pseudo-Euclidian metric remains valid but energy changes caused by gravitational radiation are considered. The classical relativistic equations of motion with variable rest mass are applied. An elementary theory of the gravitational radiation of a rotator is formulated. The results are applied for particles in circular accelerators. It is found that a rotator with non-zero mass cannot exist for an unlimited period and that it cannot exceed the velocity of light. This explains why particles with non-zero rest mass cannot attain the velocity of light in circular accelerators; it is also shown that the gravitational radiation of particles in circular accelerators does not exist in practice.

15602 MOTION OF A BODY WITH A VARIABLE MASS AND CONSTANT LOSS OF ENERGY IN A GRAVITATIONAL FIELD. G.L.Grodzovskii, Yu.N.Ivanov and V.V.Tokarev.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 5, 1082-5 (April 11, 1961). In Russian.
Treats the general case of optimization of reactive motion of such a body in a gravitational field with two centres of attraction; the corresponding variational problem is considered when one of the centres rotates round the other with constant angular velocity and at a constant radius. The resultant equation of trajectory can be integrated numerically. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 4, 310-13 (Oct., 1961)].
J.K.Skwirzynski

15603 THE GRAVITY FIELD OF A PARTICLE. II. C.Darwin.
Proc. Roy. Soc. A (GB), Vol. 263, 39-50 (Aug. 22, 1961).
Pt I (Abstr. 2101 of 1960) studied the orbits of 'comets' near a 'sun' regarded as a point source of gravitation according to general relativity. That paper expressed the forms of the orbits in terms of elliptic functions, but its method was not so well adapted to a study of the time in those orbits. In the first half of the present work these orbits and their associated times are described in a simple form, the results being expressed in terms of integrals of elementary functions, which can be easily worked out either by

quadratures or by approximation. One result of the earlier paper was the proof that no orbit can have perihelion inside r = 3m, and in the later part of the present work a method is proposed in order to study this region, since no comet can return from it. It is supposed that flashes are emitted both from a distant observatory and from a comet, each signalling the ticks of his clock according to the time it is keeping. These are observed by the other and compared with the time on its own clock. The method serves to describe occurrences between r = 3m and the 'barrier' at r = 2m, and it points to some unexpected results in the matter of the comet passing the barrier, which call for explanation.

15604 STATIONARY WEAK GRAVITATIONAL FIELDS TO ANY ORDER OF APPROXIMATION.
A.Das, P.S.Florides and J.L.Synge.
Proc. Roy. Soc. A (GB), Vol. 263, 451-72 (Oct. 10, 1961).

A method of successive approximations is set up to obtain, to any desired degree of accuracy, the field of a single body at rest, or of a material continuum in steady motion, in particular a body with an axis of symmetry about which it is steadily rotating. It is found that the internal structure of gravitating matter plays a more important role in the field outside the matter than seems to have been realized.

15605 A FREELY FALLING OBSERVER IN A RELATIVISTIC GRAVITATIONAL FIELD. K.P.Singh and S.N.Pandey.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 694-9 (Nov. 26, 1960).

It is shown how the equations of transformation may be obtained giving the field of the attracting body in terms of the coordinates of an observer falling under gravity. The role of a relativistic force of repulsion depending upon the velocity of the observer is pointed out.

15606 ON GRAVITATIONAL INSTABILITY. I.
S.Kato and S.S.Kumar.
Publ. Astron. Soc. Japan, Vol. 12, No. 2, 290-2 (1960).

Examines how the Jeans criterion of the gravitational instability should be modified under the simultaneous action of viscosity and thermal conduction. The thermal conductivity is found to replace the adiabatic sound velocity in the Jeans criterion with the isothermal sound velocity, while the viscosity has no essential effect on the criterion. The physical reason is that the medium will condense most easily in the case of isothermal condensation associated with a very slow displacement.

15607 ON GRAVITATIONAL INSTABILITY. II.
S.S.Kumar.
Publ. Astron. Soc. Japan, Vol. 12, No. 4, 552-5 (1960).

Two problems of gravitational instability of an infinite homogeneous, viscous and thermally conducting medium are considered. In Section I the gravitational instability of such a medium in rotation is considered while Section II deals with the gravitational instability of a medium in which a uniform magnetic field is present. For both cases the criterion of gravitational instability is $c'^2k^2<4\pi G\rho$, where c' is the isothermal velocity of sound, while the original Jeans criterion is $c^2k^2<4\pi G\rho$, where c is the adiabatic velocity of sound. In both cases the modification is caused by the thermal conductivity of the medium.

15608 ON GRAVITATIONAL INSTABILITY. III.
S.S.Kumar.
Publ. Astron. Soc. Japan, Vol. 13, No. 1, 121-4 (1961).

The problem of gravitational instability of a viscous, thermally conducting, rotating medium in which a uniform magnetic field is present is considered. It is found that viscosity, the Coriolis force and the magnetic field do not have any effect on the original Jeans criterion.

15609 THE GRAVITATIONAL INSTABILITY OF AN INFINITE HOMOGENEOUS ROTATING VISCOUS MEDIUM IN THE PRESENCE OF A MAGNETIC FIELD.
G.Stephenson.
Monthly Not. Roy. Astron. Soc. (GB), Vol. 122, No. 5, 455-9 (1961).

It is shown that the Jeans criterion for the gravitational instability of an infinite homogeneous medium is unaffected by the combined action of a Coriolis force, a magnetic field and a viscous force. The necessary and sufficient conditions for stability are also discussed.

15610 MAGNETOGRAVITATIONAL INSTABILITY OF AN INFINITE MEDIUM WITH FINITE ELECTRICAL AND THERMAL CONDUCTIVITY. N.K.Nayyar.
Z. Astrophys. (Germany), Vol. 52, No. 4, 266-71 (1961).

The problem of gravitational instability of an infinite gaseous medium of finite electrical and thermal conductivity, in the pr of a uniform magnetic field is studied. It is found that Jeans' criterion for gravitational instability remains essentially unaf except that the adiabatic sound velocity occuring in Jeans' con is replaced by the isothermal sound velocity.

GRAVITON—ELECTRON INTERACTION IN FUNCTIONA THEORY. See Abstr. 13298

BEHAVIOUR OF UNPERTURBED SYSTEMS IN AN INERT SPACE. See Abstr. 15585

15611 CLASSICAL RELATIVISTIC MOTION OF A POLE PARTICLE UNDER THE ACTION OF EXTERNAL PROPER SCALAR FIELDS. I.Abonyi.
Acta phys. Hungar., Vol. 13, No. 1, 11-19 (1961).

It is shown that in the case of a free particle the equations motion admit a rigorous solution which corresponds to the uni rectilinear motion. The probable existence of the runaway sol is mentioned. It is shown that in a special case the particle ca move uniformly along a straight line even under the action of a constant external field. The variation of the rest mass is stud in the case of this example and it is pointed out that the proper fi of the particle gives no contribution to the rest mass. An anal of Eliezer's integral theorem (Abstr. 32 of 1948) is derived fo particle moving in a central scalar field. Finally, it is shown certain approximation that the particle cannot perform a unifo circular motion under the action of the force derived from the Yukawa potential.

15612 A NOTE ON CIRCULAR GRAVITATIONAL ORBIT P.Goldhammer.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1205-6 (June 16, 1961).

The Schwarzschild's relativistic equation of orbits for a circulating about another fixed mass provides two circular or for a given value of angular momentum. The smaller of these orbits limits the minimum value of angular momentum which possible. The particle energies of these orbits are given and stability is noted. J.K.Skwir

15613 ON THE GENERAL FORM OF THE SPECIAL THE OF RELATIVITY. III. ON THE SUPER-LIGHT MOTION IN THE GENERAL FORM OF THE SPECIAL THEOR RELATIVITY. M.Z.v.Krzywoblocki.
Acta phys. Austriaca, Vol. 14, No. 1, 39-49 (1961).

For Pt II, see Abstr. 9312 of 1961. Presents some consi tions referring to the motion of particles with a velocity great than the velocity of light in the medium question. Two coordin transformations are applied to reduce the problem to the form equivalent to the form in the classical special theory of relati The equations for the relativistic momentum and inertial mas are identical to those obtained in the classical theory of relati

15614 ON THE GENERAL FORM OF THE SPECIAL THE OF RELATIVITY. IV. M.Z.v.Krzywoblocki.
Acta phys. Austriaca, Vol. 14, No. 2, 239-41 (1961).

The author shows that in order to obtain the most signific result of the classical special theory of relativity, i.e., the eq lence of mass and kinetic energy, it is unnecessary to enforce condition $s(x, y, z, t) = s'(x', y', z', t')$. It is sufficient to use $s = g(s')$, where $g(s')$ is any arbitrary (decent) function of s'.

15615 THE NATURE OF LIGHT PROPAGATION.
S.J.Prokhovnik.
J. Roy. Soc. New S. Wales (Australia), Vol. 95, Pt 1, 35-41 (1

By making clear distinction between the conventional mea and the proper measures of space and time intervals it is pos to achieve a consistent and physically interpretable approach special relativity. This approach implies the further distinct between the conventional measure, v, of relative velocity and "clocked" measure w. It is suggested that Einstein's light ve principle implies the relationship:

$$w = c\left(\sqrt{\frac{1 + v/c}{1 - v/c}} - 1\right),$$

thus meeting the claim that clocked velocities greater than c been observed and are required by nuclear and quantum theor It is further shown that the Lorentz transformation forms a d and necessary mathematical link between Einstein's light velo principle and the mass—energy equivalence formula, suggesti the nature of light propagation may be physically related to th

–energy transformation phenomenon. Finally the intuitive nonly accepted) approach to reflected light rays is shown to t in a hitherto unsuspected contradiction which is absent in ternative interpretation proposed.

616 ON WIGNER'S PROBLEM OF REFLECTED LIGHT SIGNALS IN DE SITTER SPACE. H.S.M.Coxeter.
. Roy. Soc. A (GB), Vol. 261, 435-42 (May 23, 1961).
See Abstr. 2133 of 1958; 4238 of 1961. Consider two material s, moving freely. One emits a light signal, the other reflects ck, the first reflects it again, and so on. When de Sitter's i is represented by the part of projective space outside a non- l quadric, the world lines of the material bodies are two nts and the world lines of the light signals form a zigzag of nts between them. Let t_{2n} be the proper time for the n-th event e first body. If the two world lines are "ultra-parallel", so that odies approach each other to a minimal distance ϕ (at time) and then recede, we have $t_{2n} = \log \tan(n\phi + \frac{1}{4}\pi)$ for $n < \pi/4\phi$. world lines intersect at time zero and form a hyperbolic angle pending on the relative velocity), we have

$$t_{2n} = \log \coth(\tfrac{1}{2} \log \coth \tfrac{1}{2}t_0 - n\phi) \quad \text{or}$$

$$-\log \coth (n\phi - \tfrac{1}{2} \log \tanh |\tfrac{1}{2}t_0|)$$

rding as t_0 is positive or negative. If the world lines are llel (in the sense of hyperbolic geometry), so that the bodies oach each other asymptotically, we have $t_{2n} = \log(2n + \epsilon)$ e $\epsilon = \exp t_0$. Finally, if the world lines are skew, t_{2n} is given icitly by a recursion formula which does not seem to have an entary solution. The first two results were obtained by Wigner her way; the third and fourth are apparently new.

5617 THE TROUTON–NOBLE EXPERIMENT IN THE PALACIOS THEORY OF RELATIVITY.
az-Bejarne.
Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 9-10, 225-36 t.-Oct., 1960). In Spanish.
The null result is explained in terms of the Palacios theory, hich the coordinate transformations are the Lorentz transfor- ions multiplied by a factor $(1 - v^2/c^2)^{1/2}$. R.A.Newing

5618 THE KINEMATICS OF INERTIAL FRAMES. R.Capildeo.
:. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 321-9 (April, 1961).
The conventional nature of time measurement is not brought to orefront, either in classical or in relativistic mechanics; it is ys taken as a consequence of the transformation equations ecting frames of reference. The author postulates that time surements depend on velocity and not only on speed. This postu- has a physical basis, as is shown by the Doppler experiment cribed. The new transformation equations are selected so that time measurements made to depend on velocity and not on speed, so the clock paradox of special relativity disappears. Under transformation, the equation $x^2 + y^2 + z^2 - c^2t^2 = 0$ is invariant. ce the speed of light is the same for all observers and the Max- equations for free space are invariant. Speeds greater than of light are permitted, but it appears that this is confined only ongitudinal pulses, parallel to the direction of motion of the ob- ver. This admits the possibility of a rigid body in relativity.
J.K.Skwirzynski

5619 A NEW SOLUTION OF THE CLOCK PARADOX. E.Kuronuma.
gr. theor. Phys. (Japan), Vol. 25, No. 3, 508-10 (March, 1961).
A simple special relativity demonstration, in terms of standard ks and light signals. F.A.E.Pirani

5620 THE GAUSS–POISSON EQUATIONS FOR STATIONARY UNIVERSES. C.Cattaneo.
. Acad. Sci. (France), Vol. 252, No. 24, 3748-50 (June 12, 1961).
rench.
The formulation (for a stationary case) of the relativistic ss–Poisson equation, when masses are subjected simultaneously ewtonian and centrifugal gravitational fields. The correspondence the classical formulation is stressed. J.K.Skwirzynski

5621 ELECTRIC AND MAGNETIC MULTIPOLE MOMENTS IN SPECIAL RELATIVITY. H.Bacry.
. Acad. Sci. (France), Vol. 252, No. 22, 3414-16 (May 29, 1961).
rench.

15622 THE DISCONTINUITIES OF THE CURVATURE TENSOR IN THE EINSTEIN–SCHRODINGER THEORY.
J.Vaillant.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 231-3 (July 10, 1961).
In French.
The equations relating the discontinuities of the connection coefficients are derived from the field equations. These equations are then resolved along the characteristic of Lichnerowicz and then analogously, along the characteristic of Maurer-Tison.
J.K.Skwirzynski

15623 DEFINITION OF UNIFORM ACCELERATION AND ITS CONFORMAL INVARIANCE. Vachaspati and L.M.Ball.
Nuovo Cimento (Italy), Vol. 21, No. 3, 442-58 (Aug. 1, 1961).
The usual equation defining uniform acceleration of a particle in special relativity, namely

$$(1 - u^2)\vec{u}'' + 3(\vec{u}\vec{u}')\vec{u}' = 0$$

where $\vec{u}$ is the velocity and primes denote differentiation with respect to time, is shown to be equivalent to

$$\text{(i)}\ \ddot{v}_\mu = Kv_\mu,$$

$\mu = 0, 1, 2, 3$ where v_μ is the four-velocity, dots denote differentiation with regard to the proper time, τ, and K is a constant. On integration this gives

$$\text{(ii)}\ v_\mu = \alpha_\mu \exp[\lambda\tau] + \beta_\mu \exp[-\lambda\tau]$$

and

$$\text{(iii)}\ x_\mu - \xi_\mu = (1/\lambda)\{\alpha_\mu \exp[\lambda\tau] - \beta_\mu \exp[-\lambda\tau]\}$$

where $\lambda = \sqrt{K}$ and α_μ, β_μ, ξ_μ are integration constants. Three-dimensional forms of these equations are given. The invariance of these equations is examined and it is shown that under the infinitesimal conformal transformations of the coordinates

$$\delta x_\mu = (ax)x_\mu - \tfrac{1}{2}x^2a_\mu, \quad [(ax) = a^\alpha x_\alpha],$$

they are invariant provided K, ξ_μ, α_μ and β_μ transform suitably, namely according to

$$\delta K = -2K(a\xi), \quad \delta\xi_\mu = (a\xi)\xi_\mu - \tfrac{1}{2}\xi^2 a_\mu + (1/K)(\tfrac{1}{2}a_\mu - 2C_\mu),$$

$$\delta\alpha_\mu = (\alpha a)\xi_\mu - (\alpha\xi)a_\mu$$

$$\delta\beta_\mu = (\beta a)\xi_\mu - (\beta\xi)a_\mu,$$

$$C_\mu = (a\beta)\alpha_\mu + (a\alpha)\beta_\mu.$$

Since the transformation law for ξ_μ is inhomogeneous, it follows that the constants ξ_μ cannot be taken zero, nor are either K or α_μ or β_μ absolute constants. It is interesting that the eq. (i) for $\ddot{v}_\mu$ is invariant only if it is considered together with its integral (ii); in turn, (ii) is invariant only if it is considered together with its integral (iii). Taken by themselves alone, neither (i) nor (ii) are conformally invariant, but (iii) is.

15624 A RELATIVISTIC ANALOGUE OF A SIMPLE NEWTONIAN RESULT. II. S.R.Roy.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 2, 140-2 (1960).
A mistake in a previous paper (Abstr. 6645 of 1960) is corrected and the correct expression for the mass of a heterogeneous spherical system is obtained.

RELATIVISTIC HYDRODYNAMICS WITH A DISCONTINUITY OF THE TRANSFORMATION OF THE REST MASS OF MATTER.
See Abstr. 15788

15625 GENERAL RELATIVITY FOR THE EXPERIMENTALIST. R.L.Forward.
Proc. Inst. Radio Engrs (USA), Vol. 49, No. 5, 892-904 (May, 1961).
Einstein's theory is broken down and simplified under limitations usually satisfied in experimentally realizable situations. Following the work of Møller (1952), an analogy between electromagnetism and gravitation is presented which allows calculation of various gravitational forces by considering the equivalent electromagnetic problem. A number of examples are included. Tensor formulation is not used except in the appendix, where justification for the analogies is given.

15626 THE POSTULATES OF A NEW THEORY OF RELATIVITY. J.Palacios.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 7-8, 195-206 (July-Aug., 1960). In Spanish.
The equations of transformation employed by the author in his

new theory of relativity (1960) are derived from the Fitzgerald contraction together with the postulate that any energy has a mass given by $m = E/c^2$. In this way, all the logical conflicts of Einstein's theory vanish.

15627 THE RECENT EXPERIMENTS ON THE RED-SHIFT AS A PROOF OF GENERAL RELATIVITY. M.A.Tonnelat.
Ann. Inst. Poincare (France), Vol. 17, No. 1, 59-89 (1961).
In French.

A careful discussion of the use of the gravitational red-shift, and in particular of whether an experimental confirmation of it is a confirmation of general relativity or of the principle of equivalence alone. The author supports the former, but "on condition that we understand by general relativity a geometrization of which that of Riemann is a particular example, and to a large extent arbitrary".
C.W.Kilmister

15628 CONSERVATION LAWS AND FERN-EQUIVALENCE IN GENERAL RELATIVITY. J.Rayski.
Acta phys. Polon. (Poland), Vol. 20, No. 7, 509-15 (1961).

A generalized parallelism (called fern-equivalence), fern-equivalent tetrads, and quasi-cartesian coordinates are defined in Riemannian geometry with the help of one-parametric families of external (minimal) hypersurfaces. The same ideas are applied to secure conservation laws and localization of energy, momentum, and angular momentum in general relativity.

15629 THE E.I.H. AND THE K-APPROXIMATION METHODS. L.Infeld.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 2, 93-7 (1961).

It is shown that the EIH technique can be applied to the one-body problem and gives the same results as usual for perihelion advance and light deflection. This fact is used to strengthen a polemic against the "new approximation method" (expansion in powers of the gravitational constant) for which no such check is known.
C.W.Kilmister

15630 ON THE MOST CARTESIAN-LIKE CO-ORDINATE SYSTEM. L.Infeld.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 299-302 (1961).

A general relativity variational principle is written down which in the first approximation yields the de Donder coordinate conditions. Under certain restrictions, coordinate conditions incompatible with the presence of gravitational radiation may be obtained.
F.A.E.Pirani

15631 RELATIVISTIC GAUSS–POISSON EQUATION IN STATIC UNIVERSES. C.Cattaneo.
C. R. Acad. Sci. (France), Vol. 252, No. 18, 2678-80 (May 3, 1961).
In French.

The equation here discussed as a natural generalization of the ordinary flat space Poisson equation, is suggested by the author's previous work (Abstr. 4258 of 1959).
F.A.E.Pirani

15632 PROPAGATORS ON A QUOTIENT SPACE. E.Combet.
C.R. Acad. Sci. (France), Vol. 252, No. 20, 3003-4 (May 15, 1961).
In French.

15633 PROPAGATORS AND COMMUTATORS IN GENERAL RELATIVITY. A.Lichnerowicz.
Cahiers de Phys. (France), Vol. 15, 189-99 (May, 1961). In French.

Development of a theory of covariant linear differential operators in Riemannian spaces. Definitions are given for (i) p-tensor distributions, which are linear functionals, taking scalar values, on p-tensors of compact support in an orientable Riemannian manifold V_n; (ii) differentiation of p-tensors; (iii) bitensors and bitensor distributions (i.e. two point tensors) on the direct square of V_n, in particular the Dirac biscalar; (iv) certain linear differential operators on p-tensors, and the corresponding propagators, which are bitensor distributions; (v) the corresponding commutators, for the free electromagnetic field and for the variation of a given gravitational field (cf. the closely related work of deWitt and Brehme, Abstr. 8538 of 1960).
F.A.E.Pirani

15634 AN ELLIPTIC SYSTEM OF EQUATIONS FOR THE CONSTRAINT PROBLEM IN GENERAL RELATIVITY. Y.Bruhat.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3411-13 (May 29, 1961).
In French.

It is shown that, by using harmonic coordinates, it is very easy to write the equations for the initial conditions (constraints) in elliptic form, taking

$$\underset{\sim}{g}^{ij} \text{ and } \frac{\partial}{\partial t}\underset{\sim}{g}^{ij} \quad (i, j = 1, 2, 3)$$

as unknowns. The extension to the Einstein–Maxwell theory is given.
C.W.Kilm

15635 THE ANTICOMMUTATOR OF THE SPINOR FIELD IN GENERAL RELATIVITY. A.Lichnerowicz.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3742-4 (June 12, 19
In French.

In order to define a rigourous anticommutator compatible the Dirac equation in general relativity (reducing to the usual in special relativity) consider, in a Riemannian space-time V_4 orthogonal ennuples, elements of a principal fibre $E(V_4)$ of the corresponding structural group (i.e. the Lorentz group) L(4). Suppose now that from $E(V_4)$ one can deduce by extension a principal fibre $S(V_4)$ of the spin group Spin(4), (this is equivale the nullity of a certain Stiefel–Whitney class). A point of $S(V_4$ called a spinor ennuple. From this covariant and contravaria spinors may be defined, and a spin connection is then an infini connection defined on the fibre by a 1-form. With a Riemanni connection of V_4 is associated a canonical spin-connection defi

$$\sigma^a_{b\rho} = \tfrac{1}{4} C^\alpha_{\beta\rho}\gamma^a_{\alpha r}\gamma^{\beta+}_b,$$

where latin indices are for spinors, the γ^is are the Dirac matr and the $C^\alpha_{\beta\rho}$ is the Riemannian connection (ennuple components
C.W.Kilm

15636 ON THE MECHANICS OF A MASS POINT IN THE GENERAL THEORY OF RELATIVITY. P.Burcev
Czech. J. Phys., Vol. 11, No. 2, 122-7 (1961).

An investigation is made into the equations of motion for points of comparable masses, the energy-momentum tensor o which is a linear function of the δ-function, in connection with principle of equivalence. If some conditions are fulfilled the equations of motion for mass points subject to a supplementar non-gravitational force effect can be transformed to equations motion for free motion of mass points in a certain equivalent gravitional field. The equivalent field, in agreement with the local validity of the principle of equivalence, is defined merel along the trajectories of the mass points.

15637 INTERNAL MOVEMENTS OF A RELATIVISTIC PARTICLE. M.Kleman.
J. Phys. Radium (France), Vol. 22, No. 7, 435-42 (July, 1961).
In French.

A relativistic particle without an external field, obeying t laws of conservation of linear momentum and angular moment is usually described by a skew tensor $M_{\mu\nu}$, its covariant deri $\dot{M}_{\mu\nu}$ and a constant linear momentum p_μ. In order to materia the physical fact of internal rotation, a second point particle w supplementary assumptions is introduced: the motion of a ma point-particle can be described as the relative motion of two particles, which is summarized by a skew tensor $\omega_{\alpha\beta}$, of the nature as the rotation pseudovector of a rigid body in classica mechanics. So a formula can be found relating the unitary vel of the two point-particles, but $\omega_{\alpha\beta}$ still depends on 6 arbitrar meters. By obvious physical considerations of reciprocity be these two point-particles (reciprocity of momenta and velociti these degrees of freedom can be made to disappear and the ro can be reduced to a simple expression. A study is then made particular class of motion for a relativistic particle, the idea reciprocity being extended to point-particles themselves. If o point-particle is given, the second is consequently found, and versa. So the so-called Weyssenhoff's motion in which the tw reciprocal points have the same space-time coordinates can b generalized.

15638 ON THE CONSERVATION LAW OF THE ANGULA MOMENTUM OF A SYSTEM OF ROTATING BODI THE GENERAL THEORY OF RELATIVITY. R.Michalska.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 4, 233-6 (1960).

Since the post-Newtonian terms in the equations of transl motion for two spherically symmetric rotating bodies are kno cause non-conservation of the orbital angular momentum, the internal angular momenta must be time-dependent. This depe is studied and it is shown that the conserved total angular mo

ır ns, as well as orbital and internal angular momenta, a term

$$\frac{1}{M} v^i v^j (m_2 S_1^{ik} + m_1 S_2^{ik})$$

h : S_1^{ik}, S_2^{ik} are the two internal angular momenta.
C.W.Kilmister

15639 ACTION PRINCIPLE FOR THE MOTION OF ROTATING BODIES IN THE GENERAL THEORY OF RELATIVITY.
.. chalska.
ie Acad. Polon. Sci. Ser. Sci. math. astron. Phys. (Poland), '8, No. 4, 237-46 (1960).
Plebański and Bażański (Abstr. 6662 of 1960) showed how, from grangian for a perfect fluid in which only dynamical variables f e fluid appear, one can deduce by considering an isolated drop n d the equations of motion of a body without internal degrees of r lom. This method is here extended to obtain the Lagrangian of c ing bodies. C.W.Kilmister

15640 THE EQUATIONS OF MOTION OF ROTATING OBLATE BODIES IN THE GENERAL THEORY OF RELATIVITY.
R ichalska.
B . Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, N 4, 247-53 (1960).
The Lagrangian of the preceding abstract is used to deduce the o -Newtonian equations of motion for two bodies. C.W.Kilmister

15641 ON THE QUANTIZATION OF THE SUPER-ENERGY OF THE GRAVITATIONAL FIELD. A.Capella.
C . Acad. Sci. (France), Vol. 252, No. 25, 3940-2 (June 19, 1961).
In rench.
The super-energy of the gravitational field (defined by inte- ing the Bel—Robinson tensor) is quantized in the linear approxi- ion, the super-energy of a graviton of frequency ν being $\hbar\nu^3/c^2$.
C.W.Kilmister

15642 DIMENSIONLESS QUANTITIES, SPACELIKE INTERVALS AND PROPER TIME IN GENERAL .ATIVITY. A.Finzi.
vo Cimento (Italy), Vol. 20, No. 6, 1079-89 (June 16, 1961).
It is shown that metric measurements, which are essential to theory of general relativity, are those based only on strong and :tromagnetic interactions. Strong and electromagnetic inter- .ons must not vary throughout the four-dimensional world, if eral relativity is to remain a meaningful theory. The implica- ıs of these remarks on cosmology are discussed.

15643 A SIMPLE DERIVATION OF THE GEODESIC EQUATIONS OF MOTION FROM THE MATTER NSOR IN GENERAL RELATIVITY USING THE δ-FUNCTION.
.Sen.
ıvo Cimento (Italy), Vol. 21, No. 1, 184-5 (July 1, 1961).
The geodesic equation of motion is derived from the field .ation by using both the Jordan's method (introduction of unction) and the Fock method (use of the continuity equation).
J.K.Skwirzynski

15644 ON STATIC SOLUTIONS IN GENERAL RELATIVITY. P.Olijnychenko.
ɔvo Cimento (Italy), Vol. 21, No. 3, 389-94 (Aug. 1, 1961).
The solution with cylindrical symmetry given by Weyl is ımined by direct calculation of R_{ik}. The result is that Weyl's ıational method is insufficient and there is no static solution for assumed form of T^{ik}. This is generalized for any distribution matter.

15645 "GAUGE-INVARIANT" VARIABLES IN GENERAL RELATIVITY. P.G.Bergmann.
ys. Rev. (USA), Vol. 124, No. 1, 274-8 (Oct. 1, 1961).
Einstein's field equations for the gravitational field possess lutions having a large variety of topological properties; among em there are solutions whose curvature goes asymptotically to ro at spatial infinity. If one is restricted to solutions that are ymptotically Minkowskian, then it is tempting to try to divide the fects of curvilinear coordinate transformations into those that rrespond to a Lorentz transformation and those that represent auge-type" effects. In fact a number of authors have followed a riety of approaches toward a reformulation of general relativity at would make the theory resemble, to some extent a conventional rentz-covariant field theory. Here the author analyses the group-theoretical aspects of such schemes. Making a definite assumption concerning the group of curvilinear transformations that will preserve the asymptotic Minkowski character of the metric field, he concludes that the reduction to a Lorentz-covariant theory is in fact impossible. The course of the analysis suggests, however, that this negative result depends on the initial group of transformations adopted; it is conceivable that a slightly different invariance group would be compatible with a special-relativistic formulation of the theory.

15646 MONOCHROMATIC WAVES IN GENERAL RELATIVITY. A.Avez.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3408-10 (May 29, 1961).
In French.
A monochromatic wave is here a function $\Psi = \exp[i\, U(x^\alpha)]$ where $\Delta_2 \Psi = 0$. For such waves to exist in the perfect fluid—Einstein—Maxwell scheme, not only must the pressure and density vanish, but the Riemann tensor is restricted. C.W.Kilmister

15647 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. V. AN EXACT SPHERICAL WAVE. L.Marder.
Proc. Roy. Soc. A (GB), Vol. 261, 91-6 (April 11, 1961).
For Pt IV see Abstr. 8548 of 1960. A construction is given for an exact solution of Einstein's empty space-time field equations representing an axially symmetric pulse wave with the properties that (i) the wave front is a sphere, outside of which all space-time is flat; (ii) a finite, expanding line singularity forms the axial diameter of this sphere. Because of (i), the solution would need to be generalized before a physical source could be introduced. The presence of radiation is confirmed by the fact that at a great distance from the centre of the wave the Riemann tensor is asymptotically of Petrov's canonical type II (with vanishing scalar invariants).

15648 GENERAL RELATIVITY AND PERIHELION ADVANCE. B.R.Rao.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 2, 168-83 (March 26, 1960).
Equations of motion which are deducible from the relativistic field equations are derived in a general coordinate system. It is shown how the form of equations of motion depends on coordinate conditions. In general the fourfold arbitrariness in the field variables due to unspecified coordinates leaves undetermined parameters in the theoretical counterparts of the observational results. It is shown how an arbitrary constant α appears in the perihelion advance.

15649 THE STATE OF TOTAL RADIATION IN THE GENERAL RELATIVITY. J.Hely.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3754-6 (June 12, 1961).
In French.
Presents complete formulation and definition of two states of total radiation; one of these is composed of the states of pure radiation in the sense of Lichnerowicz (defined in the text), the other is not. J.K.Skwirzynski

15650 ON GRAVITATIONAL RADIATION REACTION FORCES. A.Schild.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 2, 103-4 (1961).
In electrodynamics radiation may be tackled either by considering the flux of the energy tensor over distant surfaces, or by considering the radiation reaction force acting on a moving charge. The analogy to the first treatment in general relativity runs into severe trouble since the energy tensor satisfies covariant conservation identities. This note shows that the second method also presents essential difficulties. C.W.Kilmister

15651 RECURRENT RADIATION IN GENERAL RELATIVITY. D.W.Sciama.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 436-9 (April, 1961).
Describes the relation between the recurrent spaces of Ruse [Proceedings of the London Mathematical Society (GB), Vol. 53, 13 (1951)].and Walker [ibid., Vol. 52, 36 (1950)] and plane waves in general relativity. Further insight into these waves is given by the classification of recurrent spaces, which depends on the properties of the amplitude-polarization tensor. J.K.Skwirzynski

15652 AXIALLY SYMMETRIC FIELDS OF PURE RADIATION IN THE GENERAL THEORY OF RELATIVITY.
P.C.Vaidya and I.M.Pandya.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 459-63 (Sept. 26, 1960).

The field of the unidirectional flow of radiation is studied and it is proved that the charge current vector in such a field of pure flowing radiation need not vanish. If it does not vanish then it must be null vector. A new exact solution of the field equations of general relativity is derived. The solution describes the axially symmetric field of pure radiation.

15653 CONSERVATION LAWS IN THE GENERAL THEORY OF RELATIVITY. M.E.Gertsenshtein.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 114-22 (Jan., 1961). In Russian.

To determine the integral of a vector function in Riemannian geometry, and a vector field corresponding to a displacement of the origin of coordinates, a geometric operation of "harmonic" translation of the vector is introduced, which is defined in a unique manner by means of the first-order generally-covariant linear differential equations. The covariant vector components do not change during harmonic translation in a harmonic coordinate system, and this enables one to integrate the vectors by components. Therefore the energy—momentum vector, energy—momentum pseudotensor, energy density, and Hamiltonian of the system should be computed in a harmonic system. For the canonical energy—momentum tensor a unique expression is obtained which goes over to the Landau—Lifshits pseudotensor after symmetrization. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 81-6 (July, 1961)].

15654 CORIOLIS FORCES IN EINSTEIN'S UNIVERSE AND THE MACH PRINCIPLE. H.Hönl and C.Soergel-Fabricius.
Z. Phys. (Germany), Vol. 163, No. 5, 571-81 (1961). In German.

The Coriolis field generated by rotating spherical shells in Einstein's universe is calculated to a first approximation and discussed with reference to the Mach principle.

A GEOMETRICAL INTERPRETATION OF THE ELECTROMAGNETIC FIELD. See Abstr. 16497-8

15655 ON THE INFLUENCE OF A MAGNETIC DIPOLE UPON THE GRAVITATIONAL FIELD.
J.Pachner.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 475-92 (1961).

The influence of a magnetic dipole on the gravitational field is investigated under the assumptions of a body with a spherically symmetrical distribution of mass and with a weak magnetic moment. The resultant relations prove that the magnetic dipole exhibits also a weak gravitational quadrupole. The discussion of the results shows that the general relativity theory can play a certain role in the future quantum theory of elementary particles, and that there exist no measurable differences between the general relativity theory of Einstein—Maxwell and the unified field theory considered in this paper in the domains outside the elementary particles. A concluding remark deals with the influence of magnetic fields in interstellar matter on the curvature of the universe.

15656 ON THE POSSIBILITY OF A FINSLERIAN UNIFIED THEORY OF ELECTROMAGNETISM AND GRAVITATION. J.Schaer.
Arch. Sci. (Switzerland), Vol. 13, No. 4, 542-9 (Oct.-Dec., 1960). In French.

A survey of difficulties, arising from physical interpretation and from mathematical development, involved in attempts to represent the unified field in terms of the geometry of Finsler spaces. R.A.Newing

15657 THE STATIC SPHERICALLY SYMMETRIC SOLUTION IN FIVE DIMENSIONAL THEORY. H.Leutwyler.
Arch. Sci. (Switzerland), Vol. 13, No. 4, 549-55 (Oct.-Dec., 1960). In French.

A set of solutions corresponding to non-zero electromagnetic field is derived from a solution for pure gravitation by rotations involving the coordinates x^4 and x^5. R.A.Newing

15658 THE PHYSICAL BASES OF UNIFIED FIELD THEO D.W.Sciama.
Ann. Inst. Poincare (France), Vol. 17, No. 1, 1-11 (1961). In

The theory is understood in a broad sense, namely as an attempt to describe all the forces of Nature in a non-quantum by means of some non-Riemannian geometry. From this gene point of view, the principle of equivalence, equations of motion, holonomy groups are discussed, without mathematical details. F.A.E.

15659 A THEOREM IN UNIFIED FIELD THEORY WITH NON-SYMMETRIC $g_{\mu\nu}$. A.Papapetrou.
C.R. Acad. Sci. (France), Vol. 252, No. 19, 2821-3 (May 8, 196 In French.

It is shown by a series expansion method that in periodic solutions of Einstein's "weak" field equations, the first approx tion, if it is asymptotically Minkowskian (in a stated sense), m also satisfy the "strong" field equations. F.A.E.

15660 THE TWO-BODY PROBLEM IN THE JORDAN—THIRY THEORY. P.Pigeaud.
C.R. Acad. Sci. (France), Vol. 252, No. 20, 3005-7 (May 15, 19 In French.

It is shown how, by an approximate calculation, one can construct, in the Jordan—Thiry theory, solutions for the two-bod problem like those in celestial mechanics. C.W.Kil

15661 THE EQUATIONS OF VARIATIONAL UNIFIED FIE (THEORY). P.Droz-Vincent.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3405-7 (May 29, 19 In French.

A linear approximation to the asymmetric metric satisfyi unified field equations is derived by asymmetric variation of t metric tensor and the coefficients of connection of a Riemanni space. R.A.N

15662 WAVE FRONTS IN EINSTEIN'S UNIFIED THEORY GENERAL SURVEY. A.Montserrat and L.Mas.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3751-3 (June 12, 19 In French.

Continuation of Abstr. 6776 of 1961).

15663 THE PROBLEM OF MOTION IN NONSYMMETRIC UNIFIED FIELD THEORY. Nguyen Phong Chau.
C.R. Acad. Sci. (France), Vol. 252, No. 26, 4123-5 (June 26, 19 In French.

Einstein—Schrödinger theory is modified so as to yield the Coulomb force in first approximation. A force proportional to $(\text{distance})^{-4}$ also arises. F.A.E.

15664 NEW APPROACH TO EINSTEIN'S EMPTY SPACE FIELD EQUATIONS. E.T.Newman and L.A.Tambu
J. math. Phys. (USA), Vol. 2, No. 5, 667-73 (Sept.-Oct., 1961).

Tetrad formalism is used to derive a set of 36 scalar field equations which correspond to the ordinary field equations $R_{\mu\nu}$ The scalar equations are obtained by beginning with a given Pe type of empty-space Riemann tensor and applying the Ricci ide to each of the tetrad vectors. The unknowns or field variables become the 24 Ricci rotation coefficients, the number of which always be reduced by the Bianchi identities and occasionally b tetrad transformations which leave the form of the Riemann te invariant. The use of these scalar field equations is illustrate by their application to a degenerate case of Petrov type I. It i believed that by this method all possible solutions of this parti case have been found.

15665 NEW APPROACH TO THE EINSTEIN AND MAXW EINSTEIN FIELD EQUATIONS. E.T.Newman.
J. math. Phys. (USA), Vol. 2, No. 5, 674-6 (Sept.-Oct., 1961).

The components of a "vierbein" system are introduced as variables in place of the metric tensor in a Riemannian space. Riemann tensor, which is then written in terms of these new variables, is used to reformulate the Einstein and Einstein—M equations with or without a cosmological constant. These field equations have as solutions metrics with Riemann tensor of pr determined algebraic properties.

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

15666 QUANTUM MECHANICS AND THE UNIQUENESS OF THE WORLD. B.Bertotti.
o Cimento Suppl. (Italy), Vol. 17, No. 1, 1-7 (1960).
The question asked is: What is the meaning of the statement he only possible description of a physical system is a abilistic one? Both classical and quantum physics offer us a astic model of our knowledge, namely the law to carry a ability distribution forward in time. The fact that time seems et ripe to produce a better substitute should not be good enough on to assert its finality. J.K.Skwirzynski

15667 STATISTICAL THEORY OF NON-LINEAR FIELDS. J.P.Terletsky.
hys. Radium (France), Vol. 21, No. 11, 771-5 (Nov., 1960).
rench.
Canonical and microcanonical distributions of probabilities introduced for an arbitrary classical, non-linear field. Expres- s for the functional density of probability of the lines of universe found, which give particle-like solutions of the non-linear equations. Feynman's formulation of quantum mechanics is a special case of a general canonical distribution, with an ginary temperature. That temperature is interpreted as the istical temperature of a thermostat constituted of particles ing imaginary masses. Planck's constant is then a factor portional to the temperature of the "imaginary" thermostat.

15668 A COVARIANT FORMULATION OF QUANTUM MECHANICS. I. G.Szamosi.
vo Cimento (Italy), Vol. 20, No. 6, 1090-1101 (June 16, 1961).
An attempt is made to introduce explicitly the concept of an ariant time parameter (proper-time) into the relativistic one- ticle quantum mechanics. A compact unified formulation of the scalar and spin $\frac{1}{2}$ particles is presented. Covariant equations of ion, including the covariant "zitterbewegungen", are derived. quantum equations of motion are compared with the classical s and their relationships is discussed briefly.

15669 ON AN EXTENSION OF THE MATHEMATICAL FRAMEWORK OF THE QUANTUM THEORY.
Vakita.
gr. theor. Phys. (Japan), Vol. 25, No. 5, 743-52 (May, 1961).
Extending the usual framework of the quantum theory, a new thematical framework has been obtained. The most essential racter of the usual theory is preserved in the new theory, that the set of physical quantities can be represented by an operator ebra in a separable Hilbert space. In the new theory, on the er hand, the interaction Hamiltonians are treated rigorously, and se cannot be treated in the usual framwork. In the new frame- rk there are always solutions of the Schrödinger equation for any miltonian. However, the most serious defect of the theory is in fact that there is no guarantee of the uniqueness of solutions.

15670 THE INTERPRETATION OF QUANTUM MECHANICS. III. MATHEMATICAL FORMALISM. A.B.Datzeff.
Phys. Radium (France), Vol. 22, No. 1, 35-40 (Jan., 1961). In French.
As a generalization of the ideas developed in Pt I and II (Abstr. 12 of 1960; 9323 of 1961), the author arrives at the mathematical malism of prerelativistic quantum mechanics. It is shown that the ertainty relations as well as attempts at their interpretation ays have a statistical sense and that one cannot conclude from m the behaviour of an individual particle.

15671 THE INTERPRETATION OF QUANTUM MECHANICS. IV. OBSERVATION AND REALITY. A.B.Datzeff.
Phys. Radium (France), Vol. 22, No. 2, 101-12 (Feb., 1961). French.
The objective sense is ascribed to the uncertainty relations, ere observation is not a decisive factor. In accordance with s I and II, the value of each microscopic physical quantity is bject to random changes in the course of time. The deviations of ch pair of canonically conjugate quantities are not independent but nnected by the corresponding uncertainty relation.

15672 THE INTEGRAL REPRESENTATIONS OF JOST, LEHMANN AND DYSON.
V.S.Vladimirov and V.F.Nikitin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 4, 809-12 (June 1, 1961). In Russian.
Justifies the extension of this integral representation of the causality commutator, introduced by Jost and Lehmann (Abstr. 38 of 1958) and also by Dyson (Abstr. 5654 of 1958). [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

15673 CALCULATION OF PERTURBATION ENERGIES OF ANY ORDER.
F.Dupont-Bourdelet, J.Tillieu and J.Guy.
J. Phys. Radium (France), Vol. 21, No. 11, 776-8 (Nov., 1960). In French.
The perturbation energy of n^{th} order can be calculated when the perturbation functions are known up to the order n/2 for n even, or (n−1)/2 for n odd. This is a generalization of a former result obtained by Dalgarno and Stewart (Abstr. 5886 of 1957).

15674 ON THE EIGENVALUES OF THE ONE-DIMENSIONAL SCHRÖDINGER EQUATION WITH PERIODIC POTENTIAL OF SAW-TOOTHED OR ROOF-SHAPED FORM. Y.Sugiyama.
Mem. Fac. Engng Nagoya Univ. (Japan), Vol. 12, No. 1, 64-72 (May, 1960).
The equation is solved in finite space. Using the method presented by Oshida, (1951), the matrix representation of the wave function and the method analogous to the circuit theory of the four terminal network are employed. The low eigenvalues of energy are tabulated with the number of repetitions of the individual potentials. Their comparison with the eigenvalues for the periodic square-well potential is also given.

15675 EIGENVALUE PROBLEMS IN MATRIX MECHANICS. R.R.Chasman.
J. math. Phys. (USA), Vol. 2, No. 5, 733-5 (Sept.-Oct., 1961).
The techniques of the Heisenberg matrix mechanics are extended to treat all potentials of the form Q^{2n}, for n a positive integer. The square well (Q^{∞}) and the potential Q^4 are treated in detail.

15676 REMARKS ON THE CONTINUED FRACTION CALCULATION OF EIGENVALUES AND EIGENVECTORS. J.D.Swalen and L.Pierce.
J. math. Phys. (USA), Vol. 2, No. 5, 736-9 (Sept.-Oct., 1961).
For eigenvalue problems in which the secular determinant has tridiagonal form, e.g., the rigid asymmetric rotor; the secular equation may be written in the form $f(\lambda') = 0$, where $f(\lambda')$ is a continued fraction and λ' an eigenvalue. Furthermore, if the secular problem is of the nth order, then the continued fraction $f(\lambda')$ may be developed in n different ways. Since the eigenvalues are roots of a function $f(\lambda)$, it is convenient to find the eigenvalues by means of the Newton—Raphson iterative procedure. This requires that the derivative of $f(\lambda)$ with respect to $\lambda(f'(\lambda))$ be determined. An exact expression for $f'(\lambda)$ is derived and it is shown that $f'(\lambda)$ is in fact the norm of the eigenvector belonging to the eigenvalue λ'. A simple recursion formula, in continued fraction form, for the eigenvector elements is also derived. The Newton—Raphson procedure is further shown to be equivalent to the variational method for iterative calculation of eigenvalues. The former procedure has, however, the advantage of bypassing the necessity of solving a set of simultaneous equations. Advantage is taken of the relation between $f'(\lambda')$ and the eigenvector of λ' to formulate a reasonable criterion for choosing the best possible development of $f(\lambda)$ in order to avoid convergence to an undesired root of $f(\lambda)$.

15677 CALCULATION OF THE EIGENVALUES OF A TRIDIAGONAL HERMITIAN MATRIX. L.Pierce.
J. math. Phys. (USA), Vol. 2, No. 5, 740-1 (Sept.-Oct., 1961).
For real symmetric or Hermitian matrices with tridiagonal form, the secular equation may be written as a continued fraction equation $f(\lambda) = 0$. $f(\lambda)$ is a member of a recursively defined sequence $R^{(n)}(\lambda)$ of n continued fractions if the secular equation is of the nth order. The basis for a new method of computing the eigenvalues of such tridiagonal matrices is given. The method requires the determination of an integer-valued function $P_n(\gamma)$ for a succession of values of γ, where $P_n(\gamma)$ is a function only of n and the signs of the n terms in $R^{(n)}(\gamma)$.

15678 A ONE-DIMENSIONAL FIELD THEORY WITH DEGENERATE VACUUM. K.Baumann and R.Sexl.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 117-25 (July, 1961).

A one-dimensional field theory is considered corresponding to the continuous limit of a spin chain. The vacuum degeneracy of this theory is explored. Besides, it is shown that the theory can equivalently be formulated in terms of an interacting Fermi field or of a Bose field without interaction. Finally, a theory is briefly discussed which can either be treated as an interacting Bose field or as a free Fermi field.

15679 SINGLE DETERMINANT WAVE FUNCTIONS. A.T.Amos and G.G.Hall.
Proc. Roy. Soc. A (GB), Vol. 263, 483-93 (Oct. 10, 1961).

The theory of wave-functions which have the form of a single determinant, but without the restriction to doubly occupied orbitals, is developed in general terms. The unrestricted molecular orbitals, the natural spin orbitals, the natural orbitals and the corresponding orbitals are defined and some of their properties deduced. The use of annihilators and projection operators to produce eigenfunctions of spin is investigated. The role of molecular symmetry and of a truncated set of basic functions in forcing a single determinant to be an eigenfunction of spin is discussed. A theorem on the diagonalization of a rectangular matrix by two unitary matrices is proved and applied to density matrices.

15680 THE GENERALIZATION OF DIRAC'S EQUATION. I. J.Lukierski.
Acta phys. Polon. (Poland), Vol. 19, No. 4, 499-511 (1960).

An equation, invariant with respect to the 12-parameter $C \times C'$ group, for a spin $\frac{1}{2}$ field interacting with an electromagnetic field is investigated. The groups C and C' are treated symmetrically. Correspondence with Dirac's equation and bilocal theory is discussed. It is found that mass is an isovector, in a similar way as in Rayski's generalization of Pais' theory, and charge is an anti-symmetrical isotensor of second rank. The charge and mass conjugation and the existence of a charge gauge group are investigated.

15681 THE GENERALIZATION OF DIRAC'S EQUATION. II. J.Lukierski.
Acta phys. Polon. (Poland), Vol. 20, No. 7, 517-35 (1961).

The quantized Lagrangian formalism, which leads to the generalized Dirac equation introduced in Pt I (preceding abstract), is investigated. The theory is invariant with respect to the 12-parameter $C \times C'$ group. The Lagrangian is described by means of the two real isovectors: the mass-isovector $\kappa'_{;\mu}$ (introduced in Pt I) and a second isovector $\epsilon'_{;\mu}$ not occuring in the equation. The isovector $\epsilon'_{;\mu}$ is necessary for quantization invariant under $C \times C'$. It is shown that the Jauch field may be obtained and generalized after a special choice of $\epsilon'_{;\mu}$.

15682 GENERALIZATION OF THE CINI–TOUSCHEK TRANSFORMATION (EXTREME RELATIVISTIC LIMIT OF THE DIRAC EQUATIONS) BY THE METHOD OF G.MORPURGO. Phan-Van-Loc.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 78-80 (July 3, 1961).
In French.

15683 ON THE DAMPING PROBLEM IN QUANTUM THEORY. B.Mielnik.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 5, 389-93 (1961).

An exact method for solving the damping problem is presented. Previous work is shown to be an approximation in the present theory. F.Herbut

15684 THREE-VARIABLE RELATIVISTIC SCHRÖDINGER EQUATION FOR THE TWO-BODY PROBLEM. Yu.A.Gol'fand.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 2, 331-3 (May 11, 1961).
In Russian.

Denoting the 4-component vectors of the two bodies by $v(v_i)$, $w(w_i)$, with $i = 0, 1, 2, 3$, new parameters s, z are defined according to: $\cosh s = v_i v_{2i}$; $w = v \cosh s + z \sinh s$. The two-body Schrödinger equation is then formulated in terms of s, z (or their Lorentz transforms) and the 4-dimensional solid angle Ω. Lorentz-invariance is verified, and a comparison is made with the Bethe–Salpeter equation (Abstr. 1469 of 1952). [English translation in: Soviet Physics–Doklady (USA), Vol. 6, No. 5, 402-3 (Oct., 1961)]. J.W.Gardner

15685 ON THE SOLUTION OF SCHRÖDINGER EQUATIO WITH PERIODIC POTENTIAL IN THE THREE DIMENSIONAL FINITE SPACE. E.I.Takizawa.
Mem. Fac. Engng Nagoya Univ. (Japan), Vol. 12, No. 1, 59-63 (May, 1960).

Presents a method of solution of the three-dimensional ti independent Schrodinger equation in which the variables are separable and the potential is composed of a basic unit repeat a finite number of times. Both finite and infinite boundary co ditions are considered, and various forms (spherical or cylind symmetry, power series, etc.) are considered for the basic potential. A generalization is given to the n-dimensional case to the case of differential equations of higher order, and the application to branched molecules is briefly discussed. J.W.Ga

15686 LOWER BOUNDS FOR EIGENVALUES OF SCHRÖDINGER'S EQUATION. N.W.Bazley and D.W.Fox.
Phys. Rev. (USA), Vol. 124, No. 2, 483-92 (Oct. 15, 1961).

New results are given that are useful in estimating eigenv of Schrodinger's equation. Numerical applications are made f the helium atom, an anharmonic oscillator, and a radial Schro equation.

15687 LOWER-BOUND ENERGIES AND THE VIRIAL THEOREM IN WAVE MECHANICS. C.L.Caldow and C.A.Coulson.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 341-7 (April,

Several forms of the lower-bound variational method for t calculation of the eigenvalues in a wave-mechanical problem a considered, and compared; the particular case of the harmonic oscillator being chosen. All forms have certain unsatisfactory features, but some of them are considerably worse than others One reason why calculations of lower bounds are in general le satisfactory than Ritz-type calculations of an upper bound is s to be that whereas, in the presence of a scale factor, this latte wave-function satisfies the virial theorem, in none of the lowe bound wave-functions is this true. Similar calculations are re for the ground state of the helium atom.

QUANTUM MECHANICAL SYSTEMS WITH INDEFINITE METRIC. See Abstr. 13276

15688 A REMARK ON THE PROOF OF DISPERSION RELATIONS IN QUANTUM FIELD THEORY. J.G.Taylor.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 3, 694-5 (July, 1

The author proves certain analytic properties which are required for, but were overlooked in a previous paper (Abstr. 2766 of 1958). C.V

15689 ON THE COMPLETENESS PROBLEM FOR THE EIGENFUNCTION FORMULAE OF RELATIVISTIC QUANTUM MECHANICS. E.C.Titchmarsh.
Proc. Roy. Soc. A (GB), Vol. 262, 489-502 (Aug. 8, 1961).

Dirac's theory of relativistic quantum mechanics leads to problem of solving a set of four partial differential equations f the four components of the wave-function. Solutions of these equations in the case where the potential is a function of the ra coordinate only were obtained by Darwin. It is proved that the solutions form a complete set in the sense that one can simultan expand four arbitrary functions in terms of them.

15690 QUANTIZATION, STATIONARITY AND NON-LINEARITY. J. Andrade e Silva, F.Fer, P.Leruste and G.Lochak.
Cahiers de Phys. (France), Vol. 15, 210-24 (May, 1961). In Fr

The notions of stationarity and quantization, suitably defi for a probabilistic process, are discussed in their mutual rela A tentative outline of a nonlinear theory is given. F.F

15691 ON THE INTRODUCTION OF THE CONCEPT OF A GENERALIZED POTENTIAL IN NONLINEAR THE OF PARTICLES WITH SPIN AND ITS APPLICATION TO THE STUDY OF SIMPLE-STRUCTURE CORPUSCLE–FIELD MOD G.Petiau.
Cahiers de Phys. (France), Vol. 15, 157-70 (April, 1961). In F

A "clothed" corpuscle is defined as having the reaction of field included in its wave-function. The second-order partial differential wave-equations for such a corpuscle, and for the

ative corpuscle-plus-field model, are established, and the ions under which a generalized potential with these equations e associated with the models are discussed. The conditions which the equations of the two models coalesce (in terms of tential) are also discussed. J.W.Gardner

692 THE QUANTUM THEORY OF MULTIPOLE RADIATION IN A DIELECTRIC. I.Saxl.
n. J. Phys., Vol. 10, No. 9, 650-8 (1960).
The potentials of an electromagnetic field of multipoles in a tric, which is realized by a dielectric sphere having a perfectly cting surface, are derived. The diagonal values of the energy e z component of the angular momentum and the square of the ar momentum of the field are determined and also the ratio en the z component of the angular momentum and the energy e ratio between the square of the angular momentum and the e of the energy. It is shown that the total angular momentum e divided in the usual way into orbital and spin parts but that parts cannot be interpreted as the orbital and spin angular entum because their eigenvalues cannot be the eigenvalues of perator of infinitesimal rotation. In the commutation rules of ltipole field the vector character of the field is to a certain ex- suppressed and the spin of the photon (in a state with a certain of the energy, parity, z-component of the angular momentum e square of the angular momentum) is not defined.

5693 UNIQUENESS OF THE ORBITAL ANGULAR MOMENTUM OPERATORS. J.R.Shewell.
o Cimento (Italy), Vol. 20, No. 5, 1010-11 (June,1, 1961).
t is asserted that a counter example can be found to disprove a em of Lomont and Moses (Abstr. 14518 of 1960).
D.J.Thouless

5694 REPLY TO DR.SHEWELL'S CRITICISM. J.S.Lomont and H.E.Moses.
o Cimento (Italy), Vol. 20, No. 5, 1042 (June 1, 1961).
t is observed that Shewell's counter example (see preceding act) does not satisfy the necessary conditions. D.J.Thouless

5695 THE VIRIAL THEOREM FOR THE CLASSICAL PROBLEM OF THE SCATTERING OF A PARTICLE CENTRE OF FORCE. Yu.N.Demkov.
Akad. Nauk SSSR, Vol. 138, No. 1, 86-9 (May 1, 1961).
ssian.
discussion is given of the classical analogue of the generali- of the quantum-mechanical virial theorem from discrete to uous spectra, i.e. the extension to the case of unbounded m. The particular problem considered is the scattering of a le by a force centre. [English translation in: Soviet Physics— dy (USA)]. R.F.Peierls

5696 SCHRÖDINGER SCATTERING AMPLITUDE. I. A.Grossmann and Tai Tsun Wu.
ath. Phys. (USA), Vol. 2, No. 5, 710-13 (Sept.-Oct., 1961).
The Schrödinger scattering amplitude for a fixed potential is ed as a function of the three components of the initial mom- n, the three components of the final momentum, and the square of the energy.

5697 SCHRÖDINGER SCATTERING AMPLITUDE. II. A.Grossmann.
ath. Phys. (USA), Vol. 2, No. 5, 714-18 (Sept.-Oct., 1961).
The results of the preceding paper are used to: indicate pro- es of calculation of the scattering amplitude, obtain several sions, find bounds on the variation of the amplitude under a ge in the potential, and study multiple scattering.

5698 CLASSICAL APPROACH TO MOTT SCATTERING. L.V.East and P.A.Roys.
r. J. Phys., Vol. 29, No. 8, 548-9 (Aug., 1961).
Shows that classical electromagnetic theory can predict a ndence of the direction of scattering on the spin direction, in tative agreement with quantum mechanical results. It is rted that a student will receive "a better insight" if this oach is used. J.Hawgood

5699 A TIME-DEPENDENT APPROACH TO REARRANGEMENT COLLISIONS. amakrishnan, G.Ramachandran and V.Devanathan.
o Cimento (Italy), Vol. 21, No. 1, 145-54 (July 1, 1961).
A time-dependent theory of rearrangement collisions is ented which forms a simple generalization of the well-known scattering theory. The S matrix is obtained for such processes and it is found that the matrix elements appear in forms similar to those of scattering theory. As an illustration, some elementary applications are discussed.

15700 VARIATIONAL METHOD FOR SCATTERING LENGTH. T.Ohmura.
Phys. Rev. (USA), Vol. 124, No. 1, 130-4 (Oct. 1, 1961).
The properties of the scattering length obtained by Kohn's method, which is one of Hulthén's variational methods, are studied by assuming a linear trial function with n adjustable parameters. The scattering length $A^{(n)}$ decreases monotonically as the number of adjustable parameters n increases, if there is no bound state in the system. This conclusion essentially comes from the upper bound theorem of Spruch and Rosenberg (Abstr. 2496 of 1960). When the system has m bound states, the scattering length increases in value only m times, and otherwise decreases monotonically. Therefore, after one verifies the presence of m increases, the calculated value is certain to give an upper bound on the scattering length. The connection between the result above and the condition of Rosenberg, Spruch, and O'Malley (Abstr. 9288, 13405 of 1960) is considered. In the appendix comparison is made of the scattering length $A^{(n)}$ obtained by Hulthén's original method and Kohn's method when m bound states exist in general.

15701 ELEMENTARY INTERACTIONS IN SPACES WITH TORSION. R.Finkelstein.
Ann. Phys. (USA), Vol. 15, No. 2, 223-49 (Aug., 1961).
Parallel transfer is generalized to allow for the existence of a local gauge group. In spaces with torsion such a group may be introduced in a natural way and physically interpreted as a generalization of the electromagnetic gauge group. It is possible to construct simple theories of this type which correctly represent the isospin symmetries of the known fields. According to the programme here proposed the local connection of microspace is restricted by the symmetries of the observed fields; the dynamics are then determined by the curvature of space, just as in the known macroscopic limit. In the models here considered the discrete groups are not discussed and all conservation laws are exact.

15702 A GENERALIZED PERTURBATION THEORY FOR QUANTUM MECHANICAL MANY-BODY PROBLEMS. H.Primas.
Helv. phys. Acta (Switzerland), Vol. 34, No. 4, 331-51 (1961).
In German.
A generalized form of a perturbation theory for a (nonrelativistic) quantum mechanical many-body Hamiltonian is given that can be useful for problems of quantum chemistry and other problems with a moderate number of particles. A modification of Watson's t-operator allows a perturbational development of a many-body problem in terms of simpler subproblems. Some examples of such cluster approximations are given. The whole theory is formulated in operator form, no recourse is made to a representation in terms of state vectors and there are no assumptions about the degeneracy of the Hamiltonian. The given approximations to the level shift transformations are both unitary and Lie functions in every order of the development. Every step of the calculation can be done in the domain of a Lie algebra and it is recommended that, full advantage be taken of this fact in practical calculations. The use of the diagram technique is avoided and there are no explicit partial summations of the perturbation series, but similar results are gained by the systematic use of the unitary conditions, of the Lie character and the use of a modified t-operator.

15703 CONSTRUCTION OF SYMMETRY-ADAPTED FUNCTIONS IN THE MANY-PARTICLE PROBLEM. R.K.Nesbet.
J. math. Phys. (USA), Vol. 2, No. 5, 701-9 (Sept.-Oct., 1961).
A new method is presented for obtaining many-particle angular momentum eigenfunctions and matrix elements of an invariant Hamiltonian. The same technique can be used to construct symmetry-adapted functions for any group of operators that commute with the Hamiltonian, and to simplify the evaluation of matrix elements in the symmetry-adapted basis. Applied to an arbitrary configuration, the method produces orthonormal functions identical with those that would be obtained by Schmidt orthogonalization of the projections of the original basis functions of the configuration. Because of this relationship, matrix elements of the Hamiltonian are greatly simplified, but the functions are obtained without explicitly constructing the projection operators or their matrix representations. To illustrate the method, it is applied to the spin coupling of configurations

with three, four, and five particles outside closed shells, and to the two ^2D functions of the atomic configuration d^3, in Russell–Saunders coupling. Tables of the coefficients needed to evaluate all independent matrix elements are obtained for these examples, and typical matrix elements are calculated.

STATISTICAL MECHANICS TRANSFER PROCESSES

15704 EXACT STATISTICAL MECHANICS OF A ONE-DIMENSIONAL SYSTEM WITH COULOMB FORCES.
A.Lenard.
J. math. Phys. (USA), Vol. 2, No. 5, 682-93 (Sept.-Oct., 1961).

A system consisting of an equal number of positively and negatively charged "sheets" is considered in thermal equilibrium, with motion restricted to one dimension. The configurational part of the partition function can be represented as a sum of terms, each a simple algebraic expression. The summation is performed with the technique of generating functions. The asymptotic form in the limit of an infite system is obtained from the pole of the generating function closet to the origin. This pole is the solution of a certain transcendental equation for which an explicit analytic representation in terms of an infinite continued fraction is available. It is shown that this equation is identical with the characteristic equation associated with the even Mathieu functions of even order. In the limit, when the ratio of interparticle force to pressure is small, the system behaves as an ideal gas, the deviations from this state being expandable in powers of the square root of this ratio. In the opposite limit of large ratio, the particles associate in pairs of opposite charge, thus behaving like an ideal gas of neutral "molecules" which have an internal vibrational degree of freedom. The analysis may be generalized to include the effect of a constant external electric field. For a given pressure there is a critical field which can never be surpassed without disrupting equilibrium.

15705 COOPERATIVE PHENOMENA.
M.Segre.
Cienc. y Tec. (Argentina), Vol. 130, 30-44 (Jan.-Feb., 1961).
In Spanish.

A brief introduction to the study of cooperative phenomena is given, starting with the notion of partition functions, comparison of liquid with solid and gaseous states, and definition of long-range and short-range order. A short description of Ising's theory of ferromagnetism and of Bragg and William's theory of order–disorder is given. Bethe's theory is dealt with, as well as Cernuschi and Eyring's theory of condensation, which was objected to by Kirkwood. Vibrations are considered on Cernuschi and Eyring's model, overcoming Kirkwood's objections; the results agree satisfactorily with experimental data.

15706 THE GENERAL THEORY OF VAN DER WAALS FORCES.
I.E.Dzyaloshinskii, E.M.Lifshitz and L.P.Pitaevskii.
Advances in Phys. (GB), Vol. 10, No. 38, 165-209 (April, 1961).

The first half reviews Matsubara's field-theoretical method for statistical physics and its applications to the interaction between a fluctuating electromagnetic field and an inhomogeneous dielectric. This leads to a general formula for Van der Waals forces due to Dzyaloshinskii and Pitaevskii (Abstr. 10861 of 1960). The second half applies this formula to many examples and special cases including two solid bodies separated by a liquid, two atoms in a vacuum or liquid, and a thin film of liquid (e.g. helium) on a solid surface. O.Penrose

ERGODIC THEOREM IN THE SOLUTION OF THE SCALAR WAVE EQUATION WITH STATISTICAL BOUNDARY CONDITIONS. See Abstr. 16047

15707 INFORMATION THEORY AS THE BASIS FOR THERMOSTATICS AND THERMODYNAMICS. M.Tribus.
J. appl. Mech. (USA), Vol. 28, 1-8 (1961).

Information theory is well known to involve a function closely analogous to the entropy function of classical thermodynamics. In this paper the author abandons the idea that one has a mere analogy, and instead derives the whole of statistical thermodynamics on the basis of an information theoretic definition of entropy. Both closed and open systems are considered, together with Onsager's relations.
Mathematical Reviews (E.A.Buchdahl)

15708 THE MOST PROBABLE SPEED AND THE MEA MOMENTUM OF A RELATIVISTIC MAXWELLI ENSEMBLE. I.Abonyi.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3757-9 (June 12,
In French.

Using an earlier result for the partition function (Abstr. of 1960), exact mean and mean square momenta are derived Series expansions are given for the limiting cases of kT sm large compared with the rest-energy of a particle.
H.N.V.Te

15709 ON A NON-LINEAR LAW OF THE IRREVERSIB PHENOMENA WITH STATIONARY CONSTRAIN
P.Glansdorff.
Molecular Phys. (GB), Vol. 3, No. 3, 277-82 (May, 1960).

In 1954, Prigogine and the present author (Abstr. 1790 1955) established that the time derivative of the entropy pro for constant values of the fluxes, is always negative or zero when the boundary conditions of the system are stationary. However, mechanical equilibrium was postulated and it foll that the dissipative forces were not taken into consideration only the other cases of irreversibility (chemical reactions, and diffusion). In this work the above limitation is elimina The system, however, is assumed to be in mechanical stead during the whole process.

15710 INITIAL CONDITIONS IN THE THEORY OF IRR SIBLE PROCESSES. J.Philippot.
Physica (Netherlands), Vol. 27, No. 5, 490-6 (May, 1961).

Explains the physical meaning of the initial conditions van Hove and by Prigogine and his co-workers in discussing history of a large assembly described by the Hamiltonian H (the eigenfunctions of H_0 are supposed known and "irreversi appears as the result of the mixing effect of the perturbatio if this is studied in the limiting case of a large assembly of density). However, in this situation, it is physically incorr assume that initially the phases of the unperturbed eigenfun are completely random. The initial conditions used by Prig et al. are shown to be equivalent to an initial assumption o coarse-grained distribution in space. It is also permissibl an assembly that is initially described by just one of the eig tions of H_0 as in van Hove's treatment. H.N.V.T

15711 ON THE TIME DEPENDENCE OF IRREVERSIB PROCESSES IN KNUDSEN GAS. G.Pataki.
Acta Phys. Hungar., Vol. 12, No. 4, 311-19 (1960). In Russ

The time dependence of cross-effects (irreversible pro in the Knudsen gas are discussed by means of two paramet the conduction matrix. The reversal of sign of thermodyna forces was examined and found — in contrast to Onsager's effect — to be connected with the g.L matrix and not the matrix, it being off-diagonal. It was found that the reversa of the forces does not occur with a stationary initial conditi whilst in case of zero initial value of one of the forces the generally reverses its sign.

15712 THE ANGULAR MOMENTUM LAW IN THE THE DYNAMICS OF IRREVERSIBLE PROCESSES.
J.Meixner.
Z. Phys. (Germany), Vol. 164, No. 2, 145-55 (1961). In Ger

The angular momentum conservation law plays an impo part in the consideration of irreversible process in the pre electromagnetic fields. The macroscopic intrinsic angular momentum, due to electron and nuclear spins and electron in atoms and molecules, is then an additional extensive par in the development of the thermodynamic properties of matt particular irreversible process is thus associated with the momentum conservation law, and Bloch's nuclear induction may be obtained as one of the phenomenological equations.

15713 SOME PARTITION PROBLEMS WITH ANALOG QUANTUM STATISTICS. R.L.Ingraham.
Nuovo Cimento (Italy), Vol. 21, No. 8, 29-35 (July 1, 1961).

The problem of counting configurations of spins in Isin which satisfy various algebraic conditions is formally simi computing the entropy of certain many-particle systems ob Fermi–Dirac statistics. Steepest descent methods are use solve several of these problems, and the analogies with qua statistical formulae noted.

714 ON THE APPROACH TO EQUILIBRIUM IN QUANTUM SYSTEMS. P.Résibois.
ca (Netherlands), Vol. 27, No. 6, 541-70 (June, 1961).
he diagram technique used by Prigogine and others to study
proach to equilibrium of classical systems is extended to
ım systems. The similarity of the equations of Liouville and
eumann suggest the study of spatial correlations and the use
density matrix. It is claimed that the diagram technique can
eralized in ways that are intuitively almost obvious, and
ıe theory can be formally carried through in the usual limit
assembly of large volume and number of particles. Almost
ly initial assumptions required are that the "reduced
oles", e.g. volume and energy per particle should all be
, and that, initially, all correlations should be restricted to
ranges. H.N.V.Temperley

715 QUANTUM STATISTICAL ERGODIC AND H-THEOREMS FOR INCOMPLETELY SPECIFIED SYSTEMS.
Landsberg.
. Roy. Soc. A (GB), Vol. 262, 100-9 (June 13, 1961).
n incompletely specified situations the passage from quantum
anics to statistical mechanics requires an averaging process.
ally, one has to average a scalar product of a fixed unit vector
d a unit vector β of random direction over a probability distribu-
A mathematically elementary class of such averaging process-
considered. It is used to define the concept of weak uniformity
e distribution of the end point of β over the unit sphere in a
'-dimensional unitary space. In the case of strict uniformity,
Neumann's method of averaging results is valid. The distributions
in a parameter in terms of which a condition for probable ergodic-
an be formulated. It expresses a restriction which bears most
citly on the averaging process, and less explicitly on the
iltonian of the system. One finds that, while strict uniformity
arge phase cells are together sufficient for probable ergodicity,
condition by itself can occur when ergodicity is not over-
mingly probable. The averaging processes over macro-obser-
, initial states and Hamiltonians occur as special cases.

716 THEORY AND APPLICATIONS OF THE DENSITY MATRIX. D.ter Haar.
Progr. Phys. (GB), Vol. 24, 304-62 (1961).
After a qualitative discussion of the advantages of the density
ix and of the different ways to introduce it (the statistical, quan-
mechanical and operational methods of approach), section 2
s with the general properties of the density matrix, including a
ission of pure cases and mixtures. A brief discussion is given
een function techniques and of the relation between Green
ions and correlation functions. A discussion of recent develop-
s in the evaluation of partition functions concludes the first
of this article dealing with the theory of density matrix tech-
-s. Sections 5 to 9 discuss applications. The first application
e quantum-chemical one to many-body systems in their ground
. that is, systems at absolute zero, and it is shown how the
ity matrix fits into the Hartree–Fock and Thomas–Fermi
mes. A brief discussion is given of the theory of diamagnetism.
is followed by a discussion of non-equilibrium processes and
ubo's approach to transport theory. After that the polarization
eams of electrons or of photons is discussed and it is indicated
density matrix techniques can be used to treat scattering
esses. Section 9 concludes this part of the paper by a brief
unt of density matrix theory applications to resonance and
xation phenomena. Finally, the theory of measurement in
tum mechanics is considered.

QUANTUM STATISTICAL ANALOGUE OF WARD'S IDENTITY.
Abstr. 13[illegible]

717 THE GEOMETRICAL REPRESENTATION OF CERTAIN IRREVERSIBLE PHENOMENA. M.Aubert.
. Phys. (France), Vol. 5, No. 9-10, 1177-85 (Sept.-Oct., 1960).
rench.
It is pointed out that the relation between two physical quantities
ot always be represented by a smooth curve. Only certain
ts on the curve may be relevant. It is suggested that the relation
een displacement and time for a particle undergoing Brownian
ement is a non-differentiable function. For irreversible
omena such as the Joule–Thomson expansion, we can plot the
ial and final situations on a diagram of state, but there is a
e distance between the points and it is not useful to try to
ect them by a path (the irreversibility disappears if the initial
final points are very close to one another). H.N.V.Temperley

15718 TOPICS ON STATISTICAL MECHANICS OF INTERACTING PARTICLES. E.W.Montroll.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 17-148.
Contains chapters on ensembles and partition functions, cluster integral theory, transport processes, random walks on lattices and phase transitions and the Ising problem. Each field is surveyed and some typical problems are considered. 94 refs.
H.N.V.Temperley

15719 LECTURES ON STATISTICAL MECHANICS OF NON EQUILIBRIUM PHENOMENA. L.van Hove.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p.151-83.
Discusses the conduction of electricity in a simplified plasma in which the electrons and ions are supposed to interact with one another through a finite potential of finite range. The ion–ion and electron–electron interactions are neglected. The main result obtained is that Pauli's assumption, "phases of wave-function uncorrelated at all times", can be replaced by the weaker and more correct one "phases uncorrelated initially" without invalidating the standard results of weak coupling transport theory.
H.N.V.Temperley

15720 MICROSCOPIC THEORY OF IONIZED GASES. J.L.Delcroix.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 187-249. In French.
Begins with the general theory of distribution functions from which is derived Boltzmann's equation and various other results. Other topics surveyed are correlations of position in a plasma, radiation (bremsstrahlung and cyclotron), electrical conductivity and diffusion across a magnetic field. H.N.V.Temperley

15721 HYDROMAGNETICS AND THE THEORY OF PLASMA IN A STRONG MAGNETIC FIELD AND THE ENERGY PRINCIPLES FOR EQUILIBRIUM AND STABILITY. M.Kruskal.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 253-74.
Outlines the contents of a number of published and forthcoming papers on the above subjects. H.N.V.Temperley

15722 ASYMPTOTIC THEORY OF SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS WITH ALL SOLUTIONS NEARLY PERIODIC. M.Kruskal.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 277-84.
If the system of equations of lowest order has periodic solutions in a space of N dimensions, there are $N - 1$ functions of the coordinates which are constant along a trajectory. These functions are used as new coordinates, together with an angle-like variable. It is shown that this procedure can consistently be carried through to all orders of a perturbation variable, by proving that the solution to order n can always be obtained from that to order $n - 1$.
H.N.V.Temperley

15723 LANDAU DAMPING. M.Kruskal.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 287-92.
Examines the dilemma which seems to arise when one attempts to solve the Boltzmann equation for a collisionless nearly spatially uniform plasma. It is possible to obtain normal modes, in the approximation of very small disturbances, which form a complete set and are oscillatory, but are also singular functions of the velocity. To obtain a solution corresponding to a physically real distribution, one must average this over a finite range of velocities. If this is done, the whole disturbance seems to damp out with time because it involves a finite range of frequencies which interfere more and more as time goes on. The same situation is examined by an integral equation technique and is found to be analogous to non-uniform convergence of a series. H.N.V.Temperley

15724 PLASMA TRANSPORT THEORY. A.N.Kaufman.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 295-353.
The Fokker–Planck coefficients are first calculated and then used to derive the transport coefficients parallel and transverse to a magnetic field, the point of view adopted being similar to that of Chapman and Enskog. A typical nonlinear problem, "runaway", arises if the applied electric field exceeds a certain critical value.
H.N.V.Temperley

15725 STUDY OF ELECTROMAGNETIC WAVES IN PLASMAS BEGINNING WITH BOLTZMANN'S EQUATION.
J.F.Denisse.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), 357-74.
In French.

It is necessary to use an approach via the Boltzmann equation when particles of certain velocities play a special role. This occurs for example, for particles stationary with respect to a propagating wave. The phenomena considered are Landau and cyclotron absorption and longitudinal oscillations in a magnetic field. A "band-pass" phenomenon for oscillations perpendicular to the field, studied by Cross (Abstr. 4399 of 1951), is considered to be physically unimportant. H.N.V.Temperley

15726 PLASMAS IN ASTROPHYSICS.
E.Schatzman.
"Neutral and ionized gases" (see Abstr. 6800 of 1961), p. 377-469.
In French.

A large number of topics is listed. Some are discussed at length, others very briefly in note form. H.N.V.Temperley

15727 ON THE TREATMENT OF A PERTURBATION IN A SYSTEM OF PAIRED FERMIONS. A.Katz.
Nuclear Phys. (Internat.), Vol. 26, No. 1, 129-35 (July, 1961).

A straightforward variational calculation with BCS wave-functions yields expressions formerly obtained by Migdal (Abstr. 4011 of 1960) and Blatt (Abstr. 10644 of 1961) by more complicated methods. As shown by Migdal and Blatt, these expressions lead to a correct rotational moment of inertia of the system at the limit of a large system, to a correct mass in the pushing model and to a gauge invariant description of the Meissner effect.

15728 GENERALIZED SELF-CONSISTENT-FIELD AND RANDOM-PHASE APPROXIMATIONS FOR MULTI-PHASE SYSTEMS. D.E.McCumber.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 286-305 (Aug., 1961).

A formalism is presented which provides a basis for a rigorous unified quantal treatment of an extensive class of thermodynamic multi-phase many-particle systems. The thermodynamic phases considered are those associated with special spectral forms of the particle density operator, a type of hole–particle pairing operator. Fundamental to the formalism is the recognition that in self-bound systems characterized by a single "cluster", especially those whose position is not localized by external forces, the relevant particle density is that measured relative to the centre of mass. From a consistency requirement, derived equivalently from a generalized Hartree self-consistent-field approximation or from a type of random-phase approximation, an intrinsically non-linear integral equation is obtained whose solutions define a static background potential characteristic of the various phases.

15729 ON THE ASYMPTOTICAL FORMULA FOR THE THERMODYNAMICAL POTENTIAL OF FERMI PARTICLES. J.Czerwonko.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland).
Vol. 9, No. 2, 99-101 (1961).

It is observed that the variational method gives the correct value of the thermodynamic potential for a simple class of Hamiltonians. D.J.Thouless

15730 GEOMETRICAL STUDY OF THE PAIR DISTRIBUTION FUNCTION IN THE MANY-BODY PROBLEM. M.Yamada.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 579-94 (April, 1961).

The properties of pair distribution functions which are independent of physical conditions such as statistics, temperature or potential are studied. Certain inequalities are found which are always satisfied by the pair distribution function. Furthermore, other inequalities are satisfied when the particles have hard cores. These inequalities serve as subsidiary conditions in the variational treatment of many-body problems.

15731 ON THE STABILITY OF THE HARTREE–FOCK SOLUTION IN MANY-BODY PROBLEM.
K.Sawada and N.Fukuda.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 653-66 (April, 1961).

A necessary condition for the stability of the Hartree–Fock solution is presented. If this condition is not satisfied, then the solution becomes no longer stable, as was discussed by Overhauser (Abstr. 11125, 13513 of 1960) in connection with the one-dimensional spin-wave model. A variational method is proposed in this case to construct a stable solution which has definitely a lower energy than the Hartree–Fock value. The validity of this method is tested in some realistic examples such as the BCS–Bogolyubov the superconductivity. The method is then applied to field theory which seems to be inconsistent in view of the presence of "gi states". A canonical transformation leads to a new vacuum with lower energy, but the high momentum part of the couplin not damped.

15732 SOME ASPECTS OF MANY-BODY PROBLEM.
N.Fukuda and Y.Wada.
Suppl. Progr. theor. Phys, (Japan), No. 15, 61-139 (1960).

Discusses a number of the more formal problems conne with the many-body systems in quantum mechanics, with par emphasis on the collective behaviour of such systems. The problems of interacting fermions and of interacting bosons a formulated in the notation of second quantization. Perturbati theory is developed at some length in three different ways. of the problems arising in many-body theory are illustrated considering the soluble meson-pair theory. The high-densit of an electron gas is reviewed, and the expressions for the correlation energy and the specific heat correction are deriv The problem of extending the theory to lower densities is co D.J.T

15733 LOW DENSITY FERMION SYSTEMS WITH STRO ATTRACTIONS. Y.Wada.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 713-14 (April, 1

The distribution of particles in momentum space, when forces are so strongly attractive that the two-body system i is calculated and compared with the distribution for weakly ive forces and for repulsive forces. D.J.T

15734 FORMAL THEORY OF GREEN FUNCTIONS.
T.Kato, T.Kobayashi and M.Namiki.
Suppl. Progr. theor. Phys. (Japan), No. 15, 3-60 (1960).

The theory of Green functions for many-body systems i quantum mechanics is reviewed. The connection between Gr functions in quantum theory and in classical field theory is s The one- and two-particle Green functions are defined, and t equations satisfied by them are derived; it is shown that the equations for particles with spin can be simplified by introdu a real external field. The equation for the one-particle Gre function leads to the idea of a static average potential and of exchange potential. A graphical representation of the self-e part and of related functions is introduced. Similar methods developed for the two-particle functions. Perturbation theor developed, and there is some discussion of the limits of its applicability. The spectral representation is given, and the is used to calculate the response of a system to an external The relation of the Green functions to the reaction matrix ap mation is indicated. There is a discussion of one- and two-p amplitudes and their relation to Green functions, and the sta part and the fluctuation part of the effective potential are de This theory is illustrated by a discussion of the nuclear opti model and of the motion of an electron in an insulator or se conductor. Appendices deal with functional differentiation, Schwinger's dynamical principle, and the polaron problem. D.J.T

15735 THE CUT-OFF PARAMETER.
G.Ecker and D.Voslamber.
Z. Naturforsch. (Germany), Vol. 15a, No. 12, 1107-8 (Dec.,
In German.

An expression is derived for the logarithmic terms in t off theory of a system of particles with long-range interacti Two cases of one-component and two-component plasma are discussed.

15736 PERTURBATION METHOD FOR LOW STATES MANY-PARTICLE BOSON SYSTEM.
H.W.Jackson and E.Feenberg.
Ann. Phys. (USA), Vol. 15, No. 2, 266-95 (Aug., 1961).

A theoretical description of the ground state and low ex states of liquid He^4 is developed in terms of a set of correla basis functions. A simple correlated trial function ψ_0 suitab an approximate description of the ground state under the ass of a strong repulsive force when two particles approach clos proposed. The function ψ_0 and a set of model functions φ_n a to construct a set, $\psi_n = \psi_0\varphi_n$, of linearly independent correla basis functions. Matrix elements of the identify and Hamilto operator are evaluated by systematic application of a genera Kirkwood type superposition approximation. A normalized,

basis $|e_n\rangle$ is constructed from linear combinations of the ons ψ_m; the associated matrix elements $\langle e_n|H|e_m\rangle$ vanish where except on the three diagonals $m = n, n \pm 1$. This result consequence of an appropriate choice of the model functions se of the superposition approximation in evaluating the matrix ents. At this point is it proper to speak of a free phonon iption. A final approximate diagonalization, neglecting phonon—on interaction, yields explicit formulae for the ground state y and the momentum dependence of the phonon energy. The gy with Bogoliubov's treatment of the boson system (1947), uncorrelated basis functions is very close as is also the ion to Feynman's theory of the excitation energies (Abstr. of 1954). A parallel analysis is successful with ψ_0 taken to be orrect ground-state eigenfunction. In this case the matrix ents of the phonon—phonon interaction can be expressed com-ly in terms of the elementary liquid structure function as by the analysis of X-ray diffraction at low temperatures. ray is open to an accurate evaluation of the phonon energy as ction of momentum (the Landau curve) and a corresponding rate evaluation of the thermodynamic properties of the liquid w temperatures.

15737 LOW-TEMPERATURE BEHAVIOUR OF A BOSE GAS WITH HARD-SPHERE INTERACTION.

Pathria and A.D.Singh.

. Nat. Inst. Sci. India A, Vol. 26, No. 5, 520-31 (Sept. 26, 1960).

Making use of the energy—momentum relation derived by ckner and Sawada (Abstr. 6892 of 1957), the low-temperature modynamical properties of a Bose gas with hard-sphere raction are investigated. The two cases, (i) when this energy trum is similar to that observed in liquid helium II and (ii) when comes similar to that derived by Lee, Huang and Yang (Abstr. of 1957), are investigated separately. In the first case (where spectrum exhibits a non-monotonic character) the analytical vation of the expressions for the various thermodynamical erties is rendered possible by dividing the whole momentum e into three suitable intervals such that within each interval the relation can be approximated to a simple algebraic one. The erical magnitudes of the various parameters characterizing e algebraic relations are then calculated for the case of a gas density equal to that of liquid helium II and for three plausible es of the hard-sphere diameter. The calculated results agree itatively with those obtained from the experimental study of d. Further, for the second case, the expressions for the ous macroscopic properties of the assembly are derived in ns of suitable mathematical functions and then the two particular s of interest are obtained in the form of series expansions.

15738 RIGIDITY OF THE INERTIAL MOMENT OF LARGE INTERACTING MANY-FERMION SYSTEMS IN TURBATION THEORY. R.M.Rockmore.

s. Rev. (USA), Vol. 124, No. 1, 27-33 (Oct. 1, 1961).

As a result of an addendum and a correction to the author's ious work (Abstr. 76 of 1961), the vanishing of interaction cts on the inertial moment of a large many-fermion system, ng under periodic boundary conditions, in the second order of icle-particle coupling is established. The result is independent otential form. A proof extending the theorem to all orders is n.

15739 FUNDAMENTAL THERMODYNAMICS OF A SYSTEM WITH DIFFERENT ORBITAL AND SPIN MPERATURES. I. E.Fick.

Phys. (Germany), Vol. 163, No. 4, 481-8 (1961). In German.

The orbital and spin energies of a Fermi or Bose gas with erent orbital and spin temperatures depend on both temperat-s. This new thermodynamic behaviour demands a new formu-on of the fundamental thermodynamics of such a system. The damental thermodynamic notions (variables of state, work, abatic processes) are formulated and the definitions of an pirical orbital and spin temperature given. The first law hermodynamics, the definitions of orbital and spin heat, and ulting integrability conditions are discussed. There are four t capacities (instead of one for normal systems), the relations ween which are stated.

15740 GENERAL SPHERICAL HARMONICS FORMULATION OF PLASMA BOLTZMANN EQUATION.

Carpenter and F.W.Mezger.

math. Phys. (USA), Vol. 2, No. 5, 694-701 (Sept.-Oct., 1961).

The Boltzmann equation for the phase space distribution of electrons in the presence of ions is reduced to an infinite set of differential equations which do not involve angle variables. The usual method of expanding the electron phase space distribution function in terms of spherical harmonics is employed and it is assumed, in analysing the scattering process, that the ion velocities can be neglected in comparison with the electron velocities. The expansion includes both polar and azimuthal angles obviating the assumption of symmetry about a polar axis made in previous work. The differential equation for the general component of the spherical harmonics expansion is derived and explicit equations for the first few components are presented. The component equations are seen to be considerably more tractable for cases which involve electric and/or magnetic fields along a single axis.

15741 RECENT DEVELOPMENTS IN THE QUANTUM THEORY OF TRANSPORT AND GALVANOMAGNETIC PHENOMENA. M.Dresden.

Rev. mod. Phys. (USA), Vol. 33, No. 2, 265-342 (April, 1961).

This comprehensive survey paper discusses and elaborates recent aspects of transport theory, such as recent criticism of the transport equation, and density matrix techniques to evaluate transport coefficients. The complete paper will comprise seven sections, of which only the first two are given here. Section I is an extensive introductory section dealing with such topics as statistical mechanics and solid state theory as far as they apply to transport phenomena. Section II is devoted to a discussion of various ways of calculating the electrical conductivity and a criticism of these methods.

D.ter Haar

15742 COMPARISON OF ATOM AND BOND PERCOLATION PROCESSES. J.M.Hammersley.

J. math. Phys. (USA), Vol. 2, No. 5, 728-33 (Sept.-Oct., 1961).

Various inequalities, some of them strict, are proved concerning probabilities associated with percolation processes. In particular, it is shown that the critical probability of an atom percolation process is not less than the critical probability of the corresponding bond percolation process.

15743 QUANTUM-MECHANICAL MANY-PARTICLE TREATMENT OF SOUND PROPAGATION. D.E.McCumber.

Nuovo Cimento Suppl. (Italy), Vol. 17, No. 1, 8-42 (1960).

The field-theoretical Green function technique developed by Martin and Schwinger (Abstr. 896 of 1960) is used to obtain integral equations for the density correlation function or sound propagator. It is shown that in "perfect" gases sound propagation is related to single-particle damping and is thus a second-order effect.

D.ter Haar

15744 CONSERVATION LAWS AND CORRELATION FUNCTIONS. G.Baym and L.P.Kadanoff.

Phys. Rev. (USA), Vol. 124, No. 2, 287-99 (Oct. 15, 1961).

In describing transport phenomena, it is vital to build the conservation laws of number, energy, momentum, and angular momentum into the structure of the approximation used to determine the thermodynamic many-particle Green's functions. A method for generating conserving approximations is developed. This method is based on a consideration, at finite temperature, of the equations of motion obeyed by the one-particle propagator G, defined in the presence of a nonlocal external scalar field U. Approximations for G(U) are obtained by replacing the $G_2(U)$ which appears in these equations by various functionals of G(U). If the approximation for $G_2(U)$ satisfies certain simple symmetry conditions, then the G(U) thus defined obeys all the conservation laws. Furthermore, the two-particle correlation function, generated as $(\delta G/\delta U)_{U=0} = \pm L$, in terms of which all linear transport can be described, will obey all the conservation laws as well as several essential sum rules, such as the longitudinal f-sum rule. Several examples of conserving approximations are described. The Hartree approximation, $G_2(U) = G(U)G(U)$, generates the random-phase approximation for L. The Hartree—Fock approximation for G(U) leads to a natural generalization of the random-phase approximation in which hole-particle ladder diagrams are summed. Another conserving approximation for G(U) is obtained by expanding the self-energy to first order in the many-particle scattering matrix T(U). This T is obtained by summing ladder diagrams in which the sides of the ladder are composed of G(U)'s. The resulting L equation, which involves coefficients proportional to $|T|^2$, is analogous to the linearized version of the usual Boltzmann equation. Finally, in order to obtain a description of collisions in a plasma, the self-energy is expanded to first order in a dynamically shielded potential, $V_s(U)$. This potential is obtained by summing

bubbles composed of two G(U)'s. The resulting L equation is similar in structure to a Boltzmann equation in which the collision cross-section is proportional to $|V_s|^2$.

15745 ON THE KINETICS OF THE APPROACH TO EQUILIBRIUM. I.Prigogine and P.Résibois.
Physica (Netherlands), Vol. 27, No. 7, 629-46 (July, 1961).

The diagram technique developed by Prigogine and Balescu (Abstr. 10614-15 of 1960) for a classical gas is applied to obtain the solution of the system of equations. The equations obtained are valid to all orders in the coupling constant and for all times. They are non-Markovian for short times, but in the limit of long times they approach the Markovian equations obtained earlier by Henin, Résibois and Andrews (Abstr. 5210 of 1961). It is shown that the non-Markovian character of the equations does not influence the calculation of the transport coefficients which are completely determined by the asymptotic values of the cross-sections. D.ter Haar

15746 ON A NEW COMPUTATIONAL SOLUTION OF TIME-DEPENDENT TRANSPORT PROCESSES. I. ONE-DIMENSIONAL CASE. R.Bellman, R.Kalaba and M.Prestrud.
Proc. Nat. Acad. Sci. (USA), Vol. 47, No. 7, 1072-4 (July, 1961).

As a first approach to the application of the technique of invariant imbedding to time-dependent problems, the calculation of the reflected flux from a rod in neutron transport theory is considered. The problem involves the numerical inversion of a Laplace transform. Results are given graphically for reflected fluxes as functions of time for rods of various lengths. R.A.Newing

15747 TRANSPORT EQUATIONS FOR AVERAGE VALUES OF TEMPERATURE OR CONCENTRATION.
E.Ruckenstein.
Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 4, 879-86 (1960).
In Roumanian.

A general definition is given for the axial dispersion coefficient introduced by Taylor (Abstr. 6335 of 1954), which appears in the transport equation for the average concentration over the section, and it is shown that this coefficient is a consequence of the difference existing between the average concentration over the section and the average mixing concentration. The problems of the transport equations for average concentration over the section and for the average mixing concentration are also examined for the case when mass transfer occurs between two phases.

15748 A CLASS OF BOUNDARY VALUE PROBLEMS. W.E.Williams.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 1, 21-34 (1961).

A simple method is presented for the solution of the partial differential equation of diffusion type with constant values of the solution or its normal derivative prescribed on the surfaces of a wedge of arbitrary angle. It is shown that this solution may be transformed in such a manner that it yields the solution to a similar class of boundary value problems for the time-harmonic wave (i.e. Helmholtz's) equation. Direct solutions are also obtained for the problem of the diffraction of acoustic or electromagnetic plane waves by a perfectly absorbing or a perfectly reflecting wedge. In one solution the diffraction problem is solved by modifying the solution of a similar boundary value problem for the diffusion equation. In the second formulation the solution of the diffraction problem is obtained by expressing the total solution as a sum of a diffracted field and geometrical optics terms. The diffracted field is then obtained by imposing the conditions of continuity across the shadow lines of geometrical optics. The solution for the diffraction of an arbitrary plane pulse by a wedge is also obtained; the solution being valid even if the boundary conditions are of the impedance type.

15749 MILNE'S PROBLEM FOR TWO ADJACENT HALF SPACES. R.Zelazny and A.Kuszell.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 217-20 (1961).

Shows that the problem of fitting together the standard solutions for two semi-infinite media with different properties with respect to the migration of neutrons can be reduced to an integral equation. Derivation of its solution is to be published shortly. Using the form of solution quoted, it is shown how to complete the solution of the the main problem. H.N.V.Temperley

HEAT AND MASS TRANSFER IN DISPERSED MEDIA
See Abstr. 16139

NOTE ON MEASUREMENT OF RATES OF ELECTRON TRANSFER PROCESSES BY BROADENING OF E.S.R. LINES
See Abstr. 14803

15750 THE APPLICATION OF A MOMENT METHOD T SOLUTION OF NON-GRAY RADIATIVE-TRANSF PROBLEMS. P.H.Stone and J.E.Gaustad.
Astrophys. J. (USA), Vol. 134, No. 2, 456-68 (Sept., 1961).

A modified version of Krook's moment method for solvi equations of radiative transfer is presented. The method is tested with a simple step-function form for the absorption c by obtaining a large number of numerical solutions in the ze order approximation. The solutions show that the method is for a wide range of non-grey models and that a discontinuity absorption coefficient has the effect of decreasing the surfac temperature relative to a grey atmosphere with the same ef temperature.

15751 A NON-GRAY RADIATIVE-TRANSFER PROBLE G.F.Carrier and E.H.Avrett.
Astrophys. J. (USA), Vol. 134, No. 2, 469-81 (Sept., 1961).

The absorption coefficient for a stellar atmosphere dep frequency as well as depth. Often the frequency dependence characterized by a large discontinuity at each of the series In order to investigate the effect of such a discontinuity, a r atmosphere with an absorption coefficient of the simple form

$$\kappa(x,\nu) = \begin{cases} \kappa(x), & 0 \le \nu < \nu_0, \\ \epsilon^{-1}\kappa(x), & \nu > \nu_0, \end{cases}$$

is considered where ϵ is constant and small compared with Using the Eddington approximation, a highly nonlinear differ equation which is of boundary-layer type is obtained for the perature distribution. This equation is solved by conventio methods of boundary-layer theory. The calculated results a greatly reduced temperature in the outer layers of the atm (the boundary layer) and a greatly reduced amount of ultravi flux ($\nu > \nu_0$) emerging from the atmosphere. The method b the boundary-layer equation is obtained and solved is applic absorption coefficients of greater complexity and for approx of higher order than the Eddington approximation.

15752 RADIATIVE TRANSFER IN NON-GREY ATMOS V.Weidemann.
Z. Astrophys. (Germany), Vol. 52, No. 2, 132-47 (1961). In

Iterative solutions of the equation of radiative transfer shown to exist for non-grey atmospheres in local thermodyn equilibrium. The linear operator Λ introduced by Hope is replaced by a non-linear operator Ω, which represents the p of collecting light quanta to give the total absorbed radiant e per volume. It is demonstrated how repeated Ω-operation l to convergence in different cases: conservative and non-co vative problems, semi-infinite or finite, plane-parallel or d surface atmospheres. The conclusions are quite general an are based on the principle of energy conservation, which is not only locally but also integrated over the whole region un consideration.

15753 RADIATION RELAXATION TIMES AT HIGH TEMPERATURES. D.H.Sampson.
Astrophys. J. (USA), Vol. 134, No. 2, 482-99 (Sept., 1961).

A time-dependent solution to the radiative-transport eq is obtained which is valid for an optically thick medium. I principal value is that it can be used to determine, for a giv value of $\partial T/\partial t$ in the case of the energy density or $\partial\rho/\partial t$, (∇ and $\partial T/\partial t$ in the case of the flux, the approximate boundary region of matter temperature (T) and matter density (ρ) for the radiation remains in local thermodynamic equilibrium w matter. Numerical results for the radiation relaxation time for hydrogen in the temperature range $1\ \mathrm{keV} \le kT \le 16\ \mathrm{keV}$ obtained. These results can be transformed to apply to new tures or different elements. The upper range of validity of method is thought to be $\rho \cong 10^3\ \mathrm{gm\ cm^{-3}}$ and $kT \cong 64\ \mathrm{keV}$. the transformation equations can be used to obtain a rough of results for higher densities and temperatures. Although be expected that $\rho^2\Lambda_t$ would vary as ρ in the low-density lim Compton scattering is expected to be dominant, it is found t low densities, $\rho^2\Lambda_t \to$ const. $\cong \rho^2\Lambda_a/250$, where $\rho^2\Lambda_a$ is the density value for $\rho^2\Lambda_t$ due to absorptive processes alone.

54 CLASSICAL THEORY OF THE ABSORPTION OF RADIATION ENERGY BY PARTICLES. É.Le Roux.
strophys. (France), Vol. 23, No. 6, 1010-24 (1960).
nch.
onsidering a particle moving in a static potential, the energy
ed for a given direction, polarization and frequency ν is
ted, and the energy absorbed from a plane harmonic wave
particle in the same conditions. This computation is
d out using the electrodynamic equations in the framework
cial relativity. The electrodynamic form of the Hamiltonian
ons are used, with parameters particularly convenient for
g with the interaction of the system particle-static potential
ne plane wave. The spectrum of the radiated energy is then
ssed in a relatively simple form. To get the absorption, the
ial of the plane wave is considered as a perturbation of the
tonian equations. From the variations of the first integral,
riations of energy to the second order are obtained. In the
of the ergodic hypothesis of Boltzmann, a very simple
onship results between the energy radiated and the energy
bed for the same direction and with the same polarization.
particular case of thermal equilibrium the Rayleigh law
ack body radiation and (when the energy is quantified) the
k law can be obtained from this relation.

755 TABLE FOR THE EVALUATION OF THE RADIATION PRESSURE INTEGRAL K. Y.Yamashita and K.Ichimura.
Astron. Soc. Japan, Vol. 12, No. 2, 288-9 (1960).
table for evaluating the radiation pressure integral K is
ated by the mean of the four-point-sum formula.

GENERAL MECHANICS

15756 DIRECT METHOD OF SOLVING SOME TWO-DIMENSIONAL PROBLEMS OF ELASTICITY. B.Sen.
tta Mathematical Society Golden Jubilee Commemoration
ne (1958-1959) Part I. p. 173-8[Calcutta Mathematical Society,
tta-9, India].
direct method of solving problems of elastic plates with circular
having prescribed displacement on the boundary of the holes
cussed.

15757 POST-CRITICAL DEFORMATIONS OF CYLINDRICAL SHELLS UNDER THE ACTION OF EXTERNAL
SSURE. A.V.Pogorelov.
Akad. Nauk SSSR, Vol. 138, No. 6, 1325-7 (June 21, 1961).
ssian.
The edges of the shells are fixed and the pressure is applied
rmly. Deformations are called post-critical when the shape
e shell changes considerably and deformations are of the
order of magnitude as the shell dimensions. The shells are
ed into classes depending on their relative dimensions;
rical relations are provided between the first and the second
al pressures (as defined) and the elastic and geometrical
meters of shells in a particular class. [English translation
oviet Physics—Doklady (USA)]. J.K.Skwirzynski

15758 UNIQUENESS IN GENERAL BOUNDARY-VALUE PROBLEMS FOR ELASTIC OR INELASTIC SOLIDS.
.l.
ech. Phys. Solids (GB), Vol. 9, No. 2, 114-30 (April, 1961).
The class of solids considered is characterized by a linear
ion between the stress-rate and strain-rate tensors. The
dary-value problem is set by prescribed surface velocities or
nal traction-rates, the existing state of stress, anisotropy, etc.
regarded as known. Changes in geometry are unrestricted.
ous criteria for uniqueness of the solution (Hill, 1957) are re-
ed, together with related extremum principles. The results
specialized for a homogeneous isotropic elastic solid undergoing
itesimal strains, the thermodynamic restriction of positive
n energy being relaxed. For the displacement boundary-value
lem Boggio's (1907) extension of the classical uniqueness
em of Kirchhoff is recovered by an automatic process, together
related extremum principles of Gurtin and Sternberg (1960).
traction boundary-value problem is re-examined. Plane strain
generalized plane stress are also treated in detail.

15759 SOME NONLINEAR BOUNDARY VALUE PROBLEMS IN THE THEORY OF A MAXWELLIAN MEDIUM.
B.M.Naimark.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 63-6 (July 1, 1961).
In Russian.
Three types of boundary condition are considered: (1) the displacement vector specified on the boundary surface; (2) the stress-tensor components specified on the boundary surface; (3) the displacement vector specified on one part of the boundary surface and the stress tensor components specified on another part. In all cases, both the displacement vector and the stress tensor are to be found within the surface. The uniqueness of solutions is proved. [English translation in: Soviet Physics—Doklady (USA)].
J.K.Skwirzynski

15760 STRESSES IN A PIPE WITH A DISCONTINUOUS BEND. A.E.Green and W.C.Emmerson.
J. Mech. Phys. Solids (GB), Vol. 9, No. 2, 91-104 (April, 1961).
Analysis is developed for stress systems in two long straight circular cylindrical pipes which are rigidly joined together over a plane section of each pipe to form one pipe with a discontinuous bend. The analysis is restricted to pipes with a small angle between normal sections of either straight part and the plane of join. In particular, stresses are evaluated at the bend when the pipe is closed at its end and is under uniform normal internal pressure, or when the pipe is acted on by a pure symmetrical couple.

15761 THE BUCKLING OF A DISLOCATED PLATE. L.H.Mitchell and A.K.Head.
J. Mech. Phys. Solids (GB), Vol. 9, No. 2, 131-9 (April, 1961).
The buckling criteria for a thin circular dislocated plate is calculated for three types of dislocation. These are (i) a sector inserted into the plate, (ii) a sector removed from the plate, (iii) the edge dislocation of solid state physics at the centre of the plate. It is concluded that it is most unlikely that edge dislocations observed in thin metal films by electron microscopy can relieve their long range stress field by buckling the film.

15762 AN EXTENSION OF ALFREY'S ANALOGY TO THERMAL STRESS PROBLEMS IN TEMPERATURE DEPENDENT LINEAR VISCOELASTIC MEDIA.
H.H.Hilton and H.G.Russell.
J. Mech. Phys. Solids (GB), Vol. 9, No. 3, 152-64 (July, 1961).
The elastic—viscoelastic analogy due to Alfrey (1944) is extended to incorporate thermal stress problems in nonhomogeneous linear viscoelastic media. It is shown that the thermal stresses in a body possessing temperature-dependent linear viscoelastic properties can be deduced from an equivalent elastic body.

15763 TEMPERATURE-INDUCED STRESSES IN SOLIDS OF ELEMENTARY SHAPE.
L.H.Adams and R.M.Waxler.
Nat. Bur. Stand. (USA), Monogr. No. 2, 27 pp. (1960).
For two varieties of heating (sudden or constant-rate), the equations determining stress are put in convenient form for practical use, and tables of certain temperature functions are given as a means of quickly determining stresses in a slab, in a cylinder, or in a sphere subjected to either of two modes of heating. The temperature-distribution tables also provide a useful means for the ready estimation of temperature gradients.

15764 ON COMPLETE SOLUTIONS FOR FRICTIONLESS EXTRUSION IN PLANE STRAIN. J.M.Alexander.
Quart. appl. Math. (USA), Vol. 19, No. 1, 31-8 (April, 1961).
Considers the extension of partial strip line field solutions (which constitute upper bound solutions) to give the true yield point load when the material is constrained. In particular, the problem of frictionless extrusion is studied and it is shown that it is possible to extend only one of three available partial solutions. If it is not possible to extend the available partial solution, the use of discontinuous stress fields leads to lower bound solutions, and examples of this technique are given. J.K.Skwirzynski

15765 OPTICAL RESPONSE OF A PHOTOELASTIC VARNISH. J.Sapaly.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 59-60 (July 3, 1961).
In French.
A ring of photoelastic varnish (Araldite) was applied to a circular shaft; when a torque acted on the shaft the initial change in the birefringence was about 5% greater than the final change reached after a few minutes. For rings between 0.5 and 3 mm thick

the change was found to be independent of thickness. The photo-elastic method of Abstr. 4971 of 1960, was used. T.S.E.Thomas

15766 NEW KINETIC ENERGY DEMONSTRATION.
G.R.Ward.
Amer. J. Phys., Vol. 29, No. 10, 709-11 (Oct., 1961).

Kinetic energy is demonstrated by observing the height to which a small ball rises on release from an arm rotating in a vertical plane, the release taking place when the arm is horizontal. Details of the apparatus are given. E.G.Knowles

15767 SPATIAL MOTION OF ELASTIC–PLASTIC STRINGS.
N.Cristescu.
J. Mech. Phys. Solids (GB), Vol. 9, No. 3, 165-78 (July, 1961).

The problem of the integration of the equations of motion of an elastic–plastic string, which can move in space, is considered. No restrictions on the initial shape, movement and deformation of the string are imposed. Due to an impact at a point of the string, longitudinal and transverse waves propagate sumultaneously in the string. Numerical methods of integration are described.

15768 CAPSTAN EQUATION FOR STRINGS WITH RIGIDITY.
I.M.Stuart.
Brit. J. appl. Phys., Vol. 12, No. 10, 559-62 (Oct., 1961).

The effect of string rigidity on the capstan equation is considered. Two cases which cover the most likely situations are distinguished: contact of the string with the peg at a point, and contact over an arc. The analysis of these situations is facilitated by an approximation derived for the curvature for the leads of string on either side of the peg. If the friction is governed by Amontons' law, the correction of the capstan equation for string rigidity will usually be small, but in the case of arc contact and load-dependent coefficient of friction, the correction could be important.

15769 EFFECT OF A RESISTING COUPLE ON THE ROTATIONAL MOTION OF A RIGID BODY.
A.K.Weaver.
Nature (GB), Vol. 190, 335-6 (April 22, 1961).

It is pointed out that Nonweiler's proposition (Abstr. 16658 of 1960), that an external couple applied to a rigid body about its instantaneous axis of rotation tends to cause the axis to approach the axis of greatest moment does not apply to bodies under the influence of aerodynamic damping. In the case of axisymmetric bodies under the influence of aerodynamic damping, the effect is always to make the instantaneous axis move towards the axis of symmetry irrespective of whether it is the axis of greatest or least moment. It is suggested that the observed pitching and yawing of artificial earth satellites is due to non-rigidity. J.Berry

15770 THE THEORY OF THE SPINNING IMPACT OF IMPERFECTLY ELASTIC BODIES.
Z.Horák and I.Pacáková.
Czech. J. Phys., Vol. 11, No. 1, 46-65 (1961).

The first theoretical solution is given of the spinning impact of an imperfectly elastic sphere on a rigid, imperfectly rough plane. The method of solution is based on the general static theory of the impact of rough bodies (Horák, 1952). The problem leads to a non-linear differential equation, which can be solved only by an approximate numerical method. The results of the theory are in good agreement with the results of previous experiments (Horak, 1947).

15771 BEARINGS FOR HIGH SPEED ROTORS.
G.Gobert.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 39A-42A (Feb., 1961). In French.

Gives the results of various experiments which have made possible the design of bearings such that the relative tangential velocity between static and dynamic parts is greater than 300 m/sec for angular speeds greater than 3000 r.p.s.

MECHANICAL MEASUREMENT

15772 FRUSTRATED TOTAL REFLECTION — ITS AP TION TO PROXIMITY PROBLEMS IN METROLO
T.R.Young.
J. Opt. Soc. Amer., Vol. 51, No. 9, 1038-9 (Sept., 1961).

Frustrated total reflection at an air film between glass steel was used to determine the thickness of the film. W.T

15773 SIMULTANEOUS ADJUSTMENT OF ANGULAR A DISTANCE MEASUREMENTS. F.F.Ceely, Jr.
J. geophys. Res. (USA), Vol. 65, No. 9, 2845-8 (Sept., 1960).

The development and use of electronic distance-measur instruments has posed the problem that many of our triangul networks have become a mixture of triangulation, trilaterati traverse, especially in the areas where control is needed fo interstate highway programme. A method of adjusting trian trilateration, and traverse simultaneously is presented in th The formulae, methods, and techniques were devised in an a to make an adjustment that gives a satisfactory solution with distortion to both angular and distance measurements. A p ation of several approaches to the problem is made with emp given to the application of these methods to an intermediate- electronic computer.

DEVELOPMENT OF HIGH-TEMPERATURE STRAIN GA
See Abstr. 14843

15774 RADIATION RESISTANT, REMOTELY OPERAT HIGH CAPACITY SPRING BALANCE.
J.E.Ayer and G.J.Pokorny.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1114-16 (Oct., 196

A balance with a weighing range between 9 and 24 kg wa The use of radiation resistant sensing devices makes it acce for use in hot cell applications. With an unrefined read-out the system sensitivity, including resolution of chart reading at 65% confidence limits is ±10 g in 2.5 kg intervals. Over entire 9 to 24 kg range the linearity of the system is such th sensitivity is reduced to ±17 g. It is predicted that digital i of weight and use of a low inertia, low friction indicating sys will double the system sensitivity.

15775 ROTATIONAL VIBROSCOPE FOR THE COMPAR OF THE TORSIONAL PROPERTIES OF THIN FI
P.Nordon.
J. sci. Instrum. (GB), Vol. 38, No. 9, 349-51 (Sept., 1961).

An apparatus is described for the measurement of the d torsional properties of textile fibres in the frequency range 1 to 200 c/s using forced oscillations. The apparatus is par suitable for following the kinetics of the change in torsional properties caused by changes in temperature and/or humidit air surrounding the test specimen.

15776 APPLICATION OF THE PRINCIPLES OF DOUBL RESONANCE TO THE REALIZATION OF ATOM
CLOCKS. M.Arditi.
Ann. Phys. (France), Vol. 5, No. 7-8, 973-1025 (July-Aug., 1
In French.

To obtain frequency standards of high precision (1 part or 10^{10}) which are compact and mobile, the author applied th method of double resonance to the detection of the hyperfine sitions $\Delta F = 1$, $m_F = 0 \rightarrow m_F = 0$ in the vapour of alkali meta in a gas cell. To obtain maximum precision and stability the necessary to stabilize the hyperfine frequency, reduce the re line width and increase the signal to noise ratio of the detect studied. In the course of the study the hyperfine frequency o was determined with a precision about 10 times that of previ published work. The collision cross-section of sodium atom 220°C was also measured. The displacement of the hyperfin frequency produced by the pressure of the buffer gas was de mined in the case of Na^{23} and Cs^{133} and it was shown to be po to reduce it by the use of an appropriate mixture of gases. line width was reduced by using the buffer gas at high pressu and by the use of a new method of optical pumping and detect The cell with alkali metal vapour is thus equivalent to a reso circuit of $Q = 10^8$. Atomic clocks using sodium and cesium v

) control a quartz oscillator stable at the central frequency hyperfine transition. A precision and stability of 3 to 4 parts 1 is claimed. The compactness of the clocks permits their satellites. R.G.C.Arridge

'77 ACCURATE MEASUREMENT OF TIME INTERVALS OF THE ORDER OF A MICROSECOND. J.Bourguignon. rs. Radium (France), Vol. 21, Suppl. No. 11, 217A-218A 1960). In French.
ime measurements by the classic oscillographic method nt numerous disadvantages. A simple modification to the d is described which results in very accurate measurements.

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

778 A SIMPLE MECHANICAL ANALOGY FOR ISOTHERMAL COMPRESSION OF LIQUIDS AND SOLIDS.
fills, Jr.
. J. Phys., Vol. 29, No. 11, 741-3 (Nov., 1961).
When a liquid or solid is compressed isothermally, the heat y given off is greater than the work done in compressing the rial, unless the pressure is very high. This behaviour is to be characteristic of a simple and rather analogous anical system whose performance is readily calculated.

779 THE EFFECTS OF SURFACE TENSION AND VISCOSITY ON THE STABILITY OF TWO SUPER-D FLUIDS. W.H.Reid.
Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 415-25 (April, 1961).
The effect of surface tension on the stability of two superposed s can be described in a universal way by a non-dimensional ace tension number" S which provides a measure of the ive importance of surface tension and viscosity. When both s extend to infinity, the problem can be reduced to the finding roots of a quartic equation. The character of these roots is analysed so as to obtain all possible modes of stability or in-lity. Two illustrative cases are then considered in further l: an unstable case for which the density of the lower fluid is and a stable case for which the density of the upper fluid is the latter case corresponding to gravity waves. Finally, the tional principle derived by Chandrasekhar for problems of ype is critically discussed and it is shown to be of less use-ss than had been thought, especially in those cases where dic modes exist.

780 THE RELATIONSHIP BETWEEN VISCOSITY AND MOLECULAR STRUCTURE. IV. OBSERVATION OF RGY-LEVEL STRUCTURE IN THE INTERMOLECULAR ENTIAL ENERGY OF ACTIVATION FOR VISCOUS FLOW OF ER. M.M.Qurashi and A.K.M.Ahsanullah.
stan J. sci. industr. Res., Vol. 3, No. 2, 93-5 (April, 1960).
For Pt III, see Abstr. 19045 of 1960. Earlier measurements on ctivation energy, ϵ, of glycerol and ethylene glycol are wed by similar accurate measurements on water, based on the ithmic derivative of the Andrade equation, $\epsilon/k = -T^2 \Delta \ln \eta/\Delta T$ a Beckmann thermometer for accurate measurement of the C interval, ΔT. Preliminary experiments in the range of 5°C indicate the presence of a series of more or less sharp, larly occurring steps in the energy, ϵ. The temperature val between successive steps is 6 deg C on the average, as ist 12.1 deg C in the case of ethylene glycol.

5781 STUDIES IN THE RELATIONSHIP BETWEEN VISCOSITY AND MOLECULAR STRUCTURE. PRELIMINARY INVESTIGATION OF PERIODICITY IN THE IPERATURE VARIATION OF THE ACTIVATION ENERGY IN EOUS ETHYL ALCOHOL IN THE TEMPERATURE RANGE 5°C TO 55°C. A.M.Chowdhry, H.Ahmad and M.M.Qurashi.
stan J. sci. industr. Res., Vol. 3, No. 2, 101-7 (April, 1960).
Following the discovery of well-defined steps in the temperature ation of intermolecular activation energy of viscous flow in hydroxylic liquids like glycerol, ethylene glycol and water, the stigations are extended to ethyl alcohol, which has one hydroxyl p. Preliminary results obtained with a 2 deg C measuring val show the presence of a fairly regular sinusoidal variation a period of 10.4 deg C and a peak-to-peak amplitude of about 0.102 units of $(\epsilon/k)/1000$ for redistilled rectified spirits (ethyl alcohol containing 6.5% water). Similar experiments on ethyl alcohol containing 12.3% water indicate a much smaller variation of peak-to-peak amplitude of nearly 0.02 units with a period of about 8.8 deg C. These results are generally compatible with the extensive measurements already existing on the water–ethyl alcohol system, but the standard data are not accurate enough to indicate the small variations described here.

15782 STUDIES ON THE INTERFACIAL VISCOSITIES OF MONOLAYERS. J.T.Davies and G.R.A.Mayers.
Trans Faraday Soc. (GB), Vol. 56, Pt 5, 691-6 (May, 1960).
A new interfacial viscometer has been developed to measure accurately the viscosities of monlayers at the oil–water interface. It can be used to study films of interfacial viscosities from 1×10^{-4} to 10^{-1} g sec^{-1}. Measurements are reported on proteins and on solutions of cetyl alcohol and of sodium lauryl sulphate; the results are discussed in terms respectively of current theories of protein structure and of emulsion stability.

15783 THE VISCOELASTIC BEHAVIOR OF CONCENTRATED POLYMER SOLUTIONS.
T.Kotaka, M.Kurata and S.Onogi.
Suppl. Progr. theor. Phys. (Japan), No. 10, 101-20 (1959).
"Relaxation phenomena of polymers" Meeting, Kyoto, 1958 (see Abstr. 6449 of 1961). A useful review of the literature concerning linear and nonlinear viscoelastic behaviour in concentrated polymer solutions is given. In the linear case, the variation of the complex dynamic viscosity with changes in temperature, concentration and molecular weight is discussed in relation to current molecular theories. In the nonlinear case, normal stress differences and the variation of apparent viscosity with rate of shear are discussed. Bibliography. K.Walters

15784 APPARENT VISCOSITY OF A CHARGED FLUID. O.M.Stuetzer.
Phys. of Fluids (USA), Vol. 4, No. 10, 1226-31 (Oct., 1961).
Charges in a liquid or gas, under the influence of a self-created or applied field, increase the viscous losses. The general equations for a macroscopic electrohydrodynamic treatment of this phenomenon are given. Steady-state channel flow and a simple dynamic situation are theoretically investigated and compared with the magnetohydrodynamic cases. Some experiments are described.

15785 THE ELASTO-HYDRODYNAMIC LUBRICATION OF ROLLERS. G.D.Archard, F.C.Gair and W.Hirst.
Proc. Roy. Soc. A (GB), Vol. 262, 51-72 (June 13, 1961).
Gears and rollers frequently operate at loads sufficient to deform them appreciably and to enhance the viscosity of the lubricating oil in the region of closest contact. No rigorous theory of this state of lubrication has been available hitherto. In this paper an iterative procedure is developed and has been followed with a digital computer. The calculations yield the oil film thickness, the pressure distribution and the shape of the deformed system. Solutions are given showing the effect of load and speed; the influence of the pressure coefficient of viscosity of the oil, and of the elasticity of the rollers is also shown. The main feature of the results is the prediction of peaks of pressure on the outlet side of the system, the height of the peaks depending greatly upon the foregoing variables. The theory is compared with the available experimental evidence and though it is a clear improvement upon earlier theories, significant differences between theory and experiment yet remain. The origin of these differences is discussed and it is concluded that there is greater need at the present time for fuller experimental evidence than for further elaborations in the theory.

15786 EXPERIMENTAL DETERMINATION OF THE WALL EFFECT FOR SPHERES FALLING AXIALLY IN CYLINDRICAL VESSELS. V.Fidleris and R.L.Whitmore.
Brit. J. appl. Phys., Vol. 12, No. 9, 490-4 (Sept., 1961).
Experimental data of the drag exerted by the walls of a cylindrical vessel on a sphere falling axially down it through a liquid are given for Reynolds numbers, based on the diameter of the sphere, between 0.05 and 20 000. Existing wall-correction formulae are examined in the light of the new data, the conclusion being that the Francis (1933) and Munroe (1888) equations are the most reliable in the laminar- and turbulent-flow regions respectively. Graphs show the correction to be applied in the intermediate-flow region.

15787 EFFECT OF MAGNETIC FIELD AND ROTATION ON KELVIN–HELMHOLTZ INSTABILITY. Z.Alterman.
Phys. of Fluids (USA), Vol. 4, No. 10, 1207-10 (Oct., 1961).

The combined effect of a horizontal magnetic field and rotation on Kelvin–Helmholtz instability of a stratified field is considered. In two uniform fluids the short-wave perturbations are stabilized by magnetic field and surface tension, while rotation has a second-order effect. In the long-wave range the magnetic field increases the effect of rotational instability. Stability of fluids exponentially varying density is discussed.

15788 A CORRECT SOLUTION OF THE EQUATIONS [OF MOTION] IN UNIFORM RELATIVISTIC HYDRODYNAMICS WITH A DISCONTINUITY OF THE TRANSFORMATION OF THE REST MASS OF MATTER. V.A.Skripkin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 81-5 (May 1, 1961).
In Russian.

A type of motion is investigated which involves, apart from the velocity of light, a single dimensional parameter. This parameter has the dimension (mass length^{-2}). This particular solution of the equations of motion involves a discontinuity of rest mass, energy and momentum at a certain surface. [English translation in: Soviet Physics–Doklady (USA), Vol. 6, No. 5, 377-9 (Oct., 1961)].
R.Eisenschitz

15789 SUPERPOSABILITY OF STEADY AXI-SYMMETRICAL FLOWS IN A NON-NEWTONIAN FLUID. S.L.Rathna.
Proc. Indian Acad. Sci. A, Vol. 51, No. 3, 155-63 (March, 1960).

Various theorems developed by Bhatnagar and Verma (Abstr. 2148 of 1960) for the classical Newtonian fluid are extended to cover the Reiner–Rivlin non-Newtonian fluid. K.Walters

15790 COUETTE AND POISEUILLE FLOW IN NON-NEWTONIAN FLUIDS. S.L.Rathna.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 4, 392-9 (July 26, 1960).

Couette and Poiseuille flows are dealt with by taking the coefficient of viscosity and cross-viscosity as functions of second invariant of D. The present investigation supports the conclusion of Serrin [Zeitschrift für angewandte Mathematik und Mechanik, Vol. 39, 295 (1959)] in the case of Couette flow, that the strangulation of a liquid can be explained in terms of cross-viscosity.

15791 AXIAL MIGRATION OF PARTICLES IN POISEUILLE FLOW. H.L.Goldsmith and S.G.Mason.
Nature (GB), Vol. 190, 1095-6 (June 17, 1961).

The authors discuss a reported result that rigid spheres concentrate into an annular region when an initially uniform dispersion flows through a straight circular tube at particle Reynolds numbers of order 10^{-2}. Theoretical and experimental evidence is given in support of the thesis that this result applies only when the particles are deformable, and that there is no migration with solid particles. N.Curle

15792 PRINCIPLES GOVERNING THE VISCOUS FLOW OF SUSPENSOID SOLS.
T.V.Starkey, V.A.Hewlett and J.H.A.Roberts.
Brit. J. appl. Phys., Vol. 12, No. 10, 545-53 (Oct., 1961).

A theory relating to the viscous flow of stable suspensoid sols, and briefly outlined in earlier papers is extended in the present work. It suggests (i) that concentration patterns are developed within suspensoid sols as a result of shearing, (ii) that these patterns arise through the operation of "least action forces". (The existence of such forces is required in order that the principle of least action shall be applicable to those changes in the configuration of the system of particles comprising the disperse phase of the sol which accompany shearing), (iii) that the velocity distribution pattern within such a sol is related in any given case to the concentration pattern, (iv) that the anomalous properties of suspensoid sols under shear arise in consequence of the development of these patterns, and (v) that changes in these properties are due to changes in the parameters defining these patterns, and these, in turn to variations in the magnitudes of the least action forces with changes in the shearing conditions. It leads, in the case of flow through capillary tubes, to the following conclusions: (1) Shear dependence of viscosity is a universal characteristic of such sols. (2) The overall mean sol concentration within a tube during flow is always less than the concentration in the reservoir from which is is supplied. (3) The mean concentration over any cross-section diminishes systematically along a tube from a maximum value equal to the reservoir concentration (near to the entrance) to a minimum value at points nearer to the exit. (4) The overall mean sol concentration varies with flow rate from a maximum value (equal t reservoir concentration) at zero rate of flow to a minimum v (always greater than one half of the reservoir concentration) highest rate for non-turbulent flow. (5) The velocity profile, defined by the ratio of mean to maximum streaming velocity shear dependent, the ratio varying systematically between li one half and one. (6) The ratios of mean to maximum velocit of mean tube concentration to reservoir concentration are eq one another for sols showing no appreciable Brownian mover and flowing in very long tubes. (7) These velocity and concer tion ratios can under the conditions mentioned in (6), be expr as a simple function of the relative viscosity of the sol. (8) axial sol concentration increases systematically along the tu from a minimum value (equal to the reservoir concentration) the tube entrance, to a maximum value which may be many ti great at points nearer to the exit. (This hyperconcentration under appropriate conditions lead to the formation of a thron Experiments designed for the investigation of the conclusions numbered (1), (2), (4), (5) and (7) are also described. The re yielded by these experiments support the conclusions mentio In the light of these results Einstein's law, which is based on assumption of random particle distribution throughout a sol going shear, is seen to be fundamentally unsound.

15793 FLOW OF VISCO-ELASTIC LIQUIDS FROM TUB J.Harris.
Nature (GB), Vol. 190, 993 (June 10, 1961).

15794 UNSTEADY FLOW OF A VISCOUS LIQUID CONT BETWEEN TWO INFINITE CO-AXIAL CIRCULA CYLINDERS. R.Kumar.
Proc. Nat. Inst. Sci. India A, Vol. 27, No. 1, 18-26 (Jan. 26,

The unsteady motion of liquid in the presence of externa is studied by means of a transform method. In particular, s are obtained when the external forces are due to the liquid b self-gravitating or else are of the form c/r. The frictional are also calculated in each case.

INSTABILITY OF VISCOUS, THERMALLY CONDUCTIN ROTATING MEDIUM. See Abstr. 15606-8

15795 FLOW AROUND A SLENDER BODY. R.Legendre.
C.R. Acad. Sci. (France), Vol. 252, No. 17, 2508-10 (April 24
In French.

A simplified study of flow results from the use of the fie gyration of an incompressible fluid. T

15796 THE INTEGRAL RELATIONS FOR STATIONARY LAMINAR FLOW WITH CLOSED STREAMLINES A NEARLY CIRCULAR REGION. P.Jonáš.
Czech. J. Phys., Vol. 10, No. 11, 737-41 (1960). In German.

Considers the following configuration corresponding to steady flow at large Reynolds' number: a two-dimensional bounded by a nearly circular streamline Γ, a boundary layer bounded by Γ and by a nearly circular inner streamline Γ_0, inner core J bounded by Γ_0 in which the vorticity ω_0 is const For this configuration the author derives the integral relatio

$$\oint_\Gamma \left(\frac{\partial w}{\partial n}\right)_\Gamma ds = -\omega_0 \oint_\Gamma ds,$$

$$\psi_0 = K \oint_\Gamma [U^2 - u^2]\, ds,$$

where ψ_0 = flux through M, U = speed on Γ_0, u = speed on Γ, $K^{-1} = 2\omega_0 \oint_\Gamma ds$. [It seems that in a steady flow, the assum used to derive these equations will be verified only in the ca all streamlines are for all practical purposes circular. In t the unique solution of the (exact) Navier–Stokes equations w rigid rotation of the region, a flow configuration which differ markedly from the one presupposed in this paper. The autho result might, however, serve as a good approximation near t initial time for the unsteady flow obtained by rapidly setting circular boundary into rotation motion].
Mathematical Reviews (

797 THE EXISTENCE OF TURBULENT SOLUTIONS OF THE HYDRODYNAMIC EQUATIONS. J.Bass.
Acad. Sci. (France), Vol. 252, No. 22, 3392-4 (May 29, 1961).
nch.

LOW NOISE IN WATER-FILLED TUBES. See Abstr. 16012

798 FORMULATION OF THE THEORY OF TURBULENCE IN AN INCOMPRESSIBLE FLUID. H.W.Wyld, Jr.
Phys. (USA), Vol. 14, No. 1, 143-65 (July, 1961).
he theory of turbulence in an incompressible fluid is formulating methods similar to those of quantum field theory. A matic perturbation theory is set up, and the terms in the rbation series are shown to be in one to one correspondence certain diagrams analogous to Feynman diagrams. From a of the diagrams it is shown that the perturbation series e rearranged and partially summed in such a way as to e the problem to the solution of three simultaneous integral ions for three functions, one of which is the second order ity correlation function. The equations have the form of te power series integral equations, and the first few terms power series are derived from an analysis of the diagrams th order. Truncation of the integral equations at the lowest ivial order yields Chandrasekhar's equation, and truncation igher order yields the equations discussed by Kraichnan.

799 EVALUATION OF BULK VELOCITY AND TEMPERATURE FOR TURBULENT FLOW IN TUBES.
C.Rogers and Y.R.Mayhew.
nat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 55-67 (June,
Describes two methods by which bulk velocities and tempera- can be found without resorting to traversing or the use of ng chambers, in each case by only one local measurement e section considered. Both methods depend on a knowledge e velocity and temperature profiles at that section, knowledge n is now available for fully established turbulent flow in smooth s.

800 MOLECULAR THEORY OF ISOTROPIC TURBULENCE. I.M.Krieger.
. of Fluids (USA), Vol. 4, No. 5, 649-50 (May, 1961).
The Boltzmann type equation derived by Prigogine, Balescu and ger (Abstr. 9253 of 1961) is used to obtain an expression for wo-point velocity correlation function. It is concluded that r results are achieved than by starting with the Navier—Stokes tions which were originally proposed to describe non-turbulent . T.C.Toye

801 SEMI-ISOTROPIC TURBULENCE AND HELICOIDAL FLOWS. R.Betchov.
. of Fluids (USA), Vol. 4, No. 7, 925-6 (July, 1961).
Semi-isotropic turbulence is defined by the author as turbulence hich mean properties are invariant under rotations but not ctions He develops a theory of homogeneous semi-isotropic ilence in which the classical Karman—Howarth equation is lemented by a linear equation for a correlation function S(r,t), esenting the helicity of the flow. This equation appears to be upled from the Karman—Howarth equations and the author ests (without proof) that the helicoidal part of a turbulent flow outlive the fully isotropic part. N.Curle

802 CONSTANTS OF A TURBULENT ISLET IN A PERFECT BAROTROPIC FLUID. J.J.Moreau.
. Acad. Sci. (France), Vol. 252, No. 19, 2810-12 (May 8, 1961).
rench.
A portion of the fluid on the boundary of which curl $\vec{u}$ is tangen- or zero is termed a turbulent islet, where $\vec{u}$ is the field velocity. shown that during the course of motion the integral of u. curl the volume of the islet remains constant. If a sliding surface eparates two regions F' and F" of the same perfect fluid the ontinuity of velocity $\vec{u}'$ - $\vec{u}''$ on G is tangential. By introducing verage velocity $\vec{u}^* = (\vec{u}' + \vec{u}'')/2$ and replacing curl $\vec{u}\,d\tau$ by $= \vec{\alpha} \times (\vec{u}' - \vec{u}'')\,d\sigma$ where α is a unit vector perpendicular to t is shown that the surface integral of $\vec{u}.d\Xi$ is also conserved. S.S.Mitra

THE ACOUSTIC RADIATION OF TURBULENT FLOW.
Abstr. 16010

15803 FLOW THROUGH NOZZLES — FRICTIONAL AND HEAT TRANSFER EFFECTS. J.N.Beri.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 4, 422-6 (July 26, 1960).
Effects of friction and heat transfer in a divergent nozzle with initial sonic flow are considered and variations of exit Mach number with static pressure ratio presented.

15804 THE FREQUENCY OF THE FORMATION OF CAVITATIONS IN TURBULENT BOUNDARY LAYERS AND THE ACCOMPANYING FLOW. V.I.Il'ichev.
Dokl. Akad. Nauk. SSSR, Vol. 136, No. 5, 1047-50 (Feb. 11, 1961). In Russian.
It is assumed that the processes by which cavitations are formed are directly connected with the random fluctuations of the pressure. It follows that the statistical specification of these processes can be derived from the statistical specification of the fluctuations in pressure. Hence a formula is derived which can be tested experimentally and the parameters of which can be derived from observations. It is found that this formula is compatible with available observational data. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 2, 118-20 (Aug., 1961)]. R.Eisenschitz

15805 A [POSSIBLE] MODEL OF LIQUID CAVITATION. B.S.Kogarko.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 6, 1331-3 (April 21, 1961). In Russian.
An attempt is made to describe cavitation by means of the behaviour of single bubbles in a flowing liquid. Near any bubble an equation is supposed to be valid which determines the pressure in terms of the density, its first and its second time derivative. This equation is obtained from a number of plausible assumptions; it is applied to one-dimensional flow. R.Eisenschitz

NOISE FROM CAVITATING SUBMERGED WATER JETS.
See Abstr. 16045

15806 SOME CAVITATION CHARACTERISTICS OF SHIP PROPELLERS. I.A.Aleksandrov.
Akust. Zh. (USSR), Vol. 7, No. 1, 87-9 (1961). In Russian.
Deals with the results of an experimental study of cavitation on ship propellers at the instant of onset. Details of the method used are given and it was found that cavitation arises with propeller rotation speeds less than that for which the intensity of the noise radiated experiences a sudden rise. This is connected with fluctuations in the flow velocity about the blade, which result in the formation thereon of localized reduced-pressure areas in which cavitation voids are allowed to develop. It was concluded that, at the instant of onset of cavitation, fluctuations of the cavitation bubbles take place and may be approximately considered as volume fluctuations. The results led to the assumption that the cavitation on ship propellers at the instant of onset is gaseous in nature. [English translation: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 67-9 (July-Sept., 1961)]. B.Brown

15807 ENERGY TRANSPORTED BY WATER-HAMMER. A.Schlag.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3398-9 (May 29, 1961). In French.
The method introduced in a previous paper [ibid., Vol. 245, 2480 (Dec., 1957)] is used to show that the kinetic energy corresponding to the momentum transport is equal to the energy of elastic waves in the fluid and in the pipe walls. J.Hawgood

15808 DIRECT NUMERICAL CALCULATION OF WAVE PROPERTIES. J.E.Chappelear.
J. geophys. Res. (USA), Vol. 66, No. 2, 501-8 (Feb., 1961).
A numerical method for the calculation of wave properties is presented. It involves expanding the velocity components and the equation of the profile in Fourier series and determining the Fourier coefficients numerically by the method of least squares from the Bernoulli equation and from the equation insuring that the particle motion at the surface matches the profile motion. An iterative procedure is used, since the velocity coefficients depend upon the profile coefficients, and vice versa. The calculations seem always to converge to an answer, although slowly. To judge the accuracy obtained, a comparison is made with the Stokes waves. In every case the direct method is less in error.

15809 VELOCITY OF PROPAGATION OF THERMOELASTIC WAVES IN LIQUIDS. A.Carrelli and M.Marinaro.
J. Phys. Radium (France), Vol. 22, No. 6, 385-7 (June, 1961).
In French.

Investigation of conditions of establishment of this velocity of propagation, found by Lucas in liquids. A new method is proposed for its measurement in all liquids, and the results obtained for two liquids are given. The differences between this velocity and that of sound may be attributed to dispersion effects.

15810 DOUBLE, TRIPLE, AND HIGHER-ORDER DIMPLES IN THE PROFILES OF WIND-GENERATED WATER WAVES IN THE CAPILLARY–GRAVITY TRANSITION REGION. A.H.Schooley.
J. geophys. Res. (USA), Vol. 65, No. 12, 4075-9 (Dec., 1960).

Photographs of short-fetch wind-generated water waves are used to show examples of "double-dimple" wave profiles in the region of 2.44 cm wavelength as predicted by Wilton (1915). Additional experimental profiles are presented to suggest that double-dimple waves are the start of the phenomenon of 3, 4, 5, etc., dimples of capillary waves of appropriate wavelength riding in front of the crest of gravity waves having the same velocity.

15811 THE MEAN HORIZONTAL MOMENTUM AND SURFACE VELOCITY OF FINITE-AMPLITUDE RANDOM GRAVITY WAVES. O.M.Phillips.
J. geophys. Res. (USA), Vol. 65, No. 10, 3473-6 (Oct., 1960).

Simple and exact expressions for two quantities of interest in the theory of finite-amplitude random gravity waves are presented. The first is the mean horizontal momentum of the wave motion per unit projected area. The second is the mean value of the horizontal component of the fluid velocity at the free surface, measured at a fixed location in the horizontal plane. These expressions are valid for either deep or shallow water, provided the water motion is irrotational and the surface displacement $\xi(x, y, t)$ is either spatially periodic or a stationary random function of position (x, y). From these primary results, expressions are readily found for these quantities in terms of the spectrum of the surface displacement ξ that are correct to order $(\nabla\xi)^2 \ll 1$.

15812 THE TRANSMISSION OF SURFACE WAVES UNDER SURFACE OBSTACLES. F.Ursell.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 3, 638-68 (July, 1961).

A train of surface waves (water waves under gravity) is normally incident on a cylinder with horizontal generators fixed near the free surface, and is partially transmitted and partially reflected. At a great distance behind the cylinder the wave motion tends to a regular wave train travelling towards infinity; the ratio of its amplitude to the amplitude of the incident wave is the transmission coefficient T. The transmission coefficient is studied when the wavelength is short compared to the dimensions of the body; physically (though not for engineering applications) this is the most interesting range of wavelengths, which corresponds to the range of shadow formation and ray propagation in optics and acoustics. The waves are then confined to a thin layer near the free surface, and the transmission under a partially immersed obstacle is then small. In the calculation the boundary condition at the free surface is linearized, viscosity is neglected, and the motion is assumed to be irrotational. At present the transmission coefficient is known only for a few configurations, all of them relating to infinitely thin plane barriers. A method is now given which is applicable to cylinders of finite cross-section and which is worked out in detail for a half-immersed cylinder of circular cross-section. The solution of the problem is made to depend on the solution of an integral equation which is solved by iteration. Only the first two terms can be obtained with any accuracy, and it appears at first that this is not sufficient to give the leading term in the transmission coefficient at short wavelengths; this difficulty is characteristic of transmission problems. By various mathematical devices which throw light on the mechanism of wave transmission, it is, nevertheless, found possible to prove that the transmission coefficient for waves of short wavelength λ and period $2\pi/\omega$ incident on a half-immersed circular cylinder of radius a is asymptotically given by $T \sim 2/\pi N^4$ when $N = 2\pi a/\lambda = \omega^2 a/g$ is large. Earlier evidence had pointed towards an exponential law. It is suggested that transmission coefficients of order N^{-4} are typical for obstacles having vertical tangents and finite non-zero radius of curvature at the points where they meet the horizontal mean free surface. For obstacles having both front and rear face plane vertical to a depth a, T is probably of order e^{-2N} approximately; if only one of the two is plane vertical, T is probably of order e^{-N} approximately. T is seen to depend critically on the details of the cross-se

15813 A THEORETICAL STUDY OF WAVES BREAKIN ANGLE WITH A SHORE LINE. B. Le Méhauté.
J. geophys. Res. (USA), Vol. 66, No. 2, 495-9 (Feb., 1961).

By hydrodynamic theory, the height and "wavelength" o breaking wave, the depth of breaking, and the angle of the b crest with a straight shore line on a gently sloping beach ar calculated from the height, length, and angle of the wave in of infinite depth. These calculations, which are based on a order approximate theory, are presented on a chart. The p of calculation for a higher order is also indicated.

15814 THE PULSATING VISCOUS FLOW SUPERPOSE THE STEADY LAMINAR MOTION OF INCOMPI FLUID BETWEEN TWO CO-AXIAL CYLINDERS. P.D.Ver
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 447-58 (Sept. 2

The general periodic motions superposed on steady Po flow through both co-axial circular cylinders and confocal e cylinders, which cause transmission of fluid mass in one di are solved in an exact form. In the case of very small freq the motion in the channel at each instant is the same as the motion in the channel under a constant pressure gradient, w large frequencies the maxima of velocity distribution exist neighbourhood of the wall.

15815 THE MATHEMATICAL THEORY OF CAPILLAR F.C.Goodrich.
Proc. Roy. Soc. A (GB), Vol. 260, 481-9 (March 21, 1961).

The problems of static meniscus formation and shallow motion on incompressible, inviscid fluids are reviewed. So results on static menisci are presented.

15816 THE MATHEMATICAL THEORY OF CAPILLAR F.C.Goodrich.
Proc. Roy. Soc. A (GB), Vol. 260, 490-502 (March 21, 1961)

A model is proposed whereby the hydrodynamic theory shallow, capillary surface waves is modified by the inclusio Newtonian viscosity terms peculiar to the interface. The ir tions of the theory are evaluated for two special cases: (1) motion of low-frequency and very high-surface viscosity (c damped motion). (2) Wave motion of moderate to high-freq and low-surface viscosity (slightly damped motion). In the case, the effects of internal viscosity in the substrate are considered.

15817 THE MATHEMATICAL THEORY OF CAPILLAR F.C.Goodrich.
Proc. Roy. Soc. A (GB), Vol. 260, 503-9 (March 21, 1961).

The theoretical predictions of Pt I and II are subjected experimental examination. The experiments are of two typ very slow distortion of highly viscous surface films, the Ins tensile tester machine being used, and (2) measurement of space attenuation of a plane ripple on a water surface cover an oil film. Only (2) appears to be promising, but the data interpreted only by assuming that there exists a certain am horizontal slip between film and substrate.

15818 SURFACE TENSION OF WATER. R.F.Simonin.
C.R.Acad. Sci. (France), Vol. 252, No. 21, 3192-4 (May 24,
In French.

The equation of motion of bombarded surface molecules found to be equivalent to that of a simple pendulum whose le independent of the system of units adopted. It is deduced th bombarded surface molecule is subjected to a tangential an centripetal force whose resultant balances its weight; it is c cluded that the surface tension is the weight of the surface molecules distributed along the air–water interface.

H.H

15819 CONTACT ANGLES; WETTING AND DE-WETT MERCURY. I. A CRITICAL EXAMINATION O SURFACE TENSION MEASUREMENT BY THE SESSILE DR METHOD. C.A.Smolders and E.M.Duyvis.
Recueil Trav. chim. Pays-Bas (Netherlands), Vol.80, No.7 635-49 (July, 1961).

A survey is given of the existing methods for measurin surface tension from the geometry of sessile drops. These

ds, which generally consist of the measurement of simple limensions, are insufficiently accurate for use with adsorp- udies. A new procedure is described to find the surface n by means of a graphical evaluation of the drop-shape β (the constant shape factor as defined in Bashforth and 's treatment (1883) of the sessile drop). In this way the acy is considerably increased (0.1% uncertainty in γ). The acial tension of the system mercury/0.05 M Na_2SO_4 at) V versus saturated calomel electrode, and at 25°, is found 426.2 ± 0.2 dynes/cm, which agrees well with the literature.

20 CONTACT ANGLES; WETTING AND DE-WETTING OF MERCURY. II. THEORY OF WETTING.
nolders.
il Trav. chim. Pays-Bas (Netherlands), Vol. 80, No. 7, 650-8 1961).
theory is given for the behaviour of contact angles, as a ın of the concentration of surface active substances, ed in wetting and de-wetting experiments of metal and al surfaces. It is shown, that the change of the contact angle olute concentration can be related quantitatively to the adsorp- ensities at the three interfaces, which meet at the line of t. Some published results are discussed in terms of the developed.

121 EFFECT OF SURFACE TENSION ON THE KELVIN–HELMHOLTZ INSTABILITY OF TWO ROTATING JS. Z.Alterman.
Nat. Acad. Sci. USA, Vol. 47, No. 2, 224-7 (Feb., 1961).
ırface tension stabilizes the motion for short-wavelength dis- ıces, but, for a rotating system, there is instability for large engths both with and without surface tension. In other words, rotating system can be completely stabilized by surface n but a rotating system cannot. This situation is contrasted ıat for Rayleigh–Taylor instability. H.N.V.Temperley

322 ON THE SURFACE TENSION OF ROTATING LIQUIDS. M.Borneas and I.Băbuţia.
phys. Polon. (Poland), Vol. 20, No. 3, 187-96 (1961).
he surface tension of liquids changes if they are rotating. is an effect specific to rotation: a rotational kinetic effect . The principal factors determining the r.e. are: the compo- of the liquid, its temperature, velocity of rotation, and ous treatment. The experimental procedure is described. ependence of the r.e. on the temperature is shown, and s for different frequencies are given. The previous thermal and anical treatment is discussed. It is shown that the r.e. hes at a certain temperature characteristic of the liquid, but endent of the velocity of rotation. Finally, an explanation of ienomenon is attempted.

823 CAPILLARY PRESSURE AND SURFACE DISCONTINUITY IN POROUS MEDIA.
ınnapragada and W.Rose.
ophys. Res. (USA), Vol. 66, No. 4, 1199-201 (April, 1961).
A derivation of the capillary pressure term for viscous fluids luid–fluid interface is given in the general form. Hall's ısactions of the American Geophysical Union, Vol. 37, 1 (1956)] paper is discussed in part, and it is emphasized he surface of discontinuity between the fluids cannot be ed in describing the dynamics of multiphase fluid flow through ous medium.

824 FLUID–FLUID INTERFACES IN STEADY MOTION. W.Rose.
e (GB), Vol. 191, 242-3 (July 15, 1961).
n a capillary channel of constant cross-section with a wetting displacing another immiscible one at a constant rate, the -fluid interface advances at a steady velocity. It is shown that points on the surface of the interface the tangential component ocity must be zero, or, in other words, no pressure gradients ntial to the surface exist in either phase. Since the curvature luid–fluid interface at a particular point is proportional to ·essure difference between fluid pressures in each phase at ıuous points across the interface, absence of pressure gradients her phase tangential to the surface implies a constant curvature ghout the interface (distortions due to gravity are neglected as plification). S.S.Mitra

825 ON THE PENDENT DROP. I. K.Tamada and Y.Shibaoka.
ys. Soc. Japan, Vol. 16, No. 6, 1249-52 (June, 1961).
The equilibrium of a pendent drop which appears on the film of water covering a horizontal surface is discussed. It is found that the volume of the drop takes a maximum value at a special configuration of $D/H \cong 3$, where D is the diameter and H the depth, of the drop. Solutions for the equilibrium beyond this maximum cannot be realized in the actual drop, since there is slight but steady current of water into the drop from the surrounding film. The drop, in reality, becomes unstable for external disturbance and collapse just before the said limit is reached. An analytical solution is obtainable for the case of a two-dimensional drop, the cross-sectional area of which is also seen to attain a maximum at $D/H \cong 1.9$.

15826 STUDY OF THE VIBRATING REED IN THE PRODUCTION OF SMALL DROPLETS AND SOLID PARTICLES OF UNIFORM SIZE. W.R.Wolf.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1124-9 (Oct., 1961).
The production of uniformly sized droplets of pure liquids, solutions, suspensions, and of solid particles in the size range of 4 to 200 μ in diameter employing the vibrating reed is described. Salient features of the various devices are discussed where particular attention is devoted to the stability in size uniformity of the droplets or particles produced and their mechanism of formation. The methods described have found application in a variety of fundamental investigations, such as droplet evaporation and plant growth regulator studies, but their inherent low capacity makes them less suited for large-volume aerosols or sprays as are encountered, for example, in spray drying.

15827 NOTE ON PARTICLE VELOCITY IN COLLISIONS BETWEEN LIQUID DROPS AND SOLIDS. O.G.Engel.
J. Res. Nat. Bur. Stand. (USA), Vol. 64A, No. 6, 497-8 (Nov.-Dec., 1960).
Equations are developed for plane-wave particle velocity produced in solid-against-liquid collisions. An explicit expression for the dimensionless coefficient α that appears in these equations is deduced.

15828 THE MEASUREMENT OF FILM ELASTICITY. K.J.Mysels, M.C.Cox and J.D.Skewis.
J. phys. Chem. (USA), Vol. 65, No. 7, 1107-11 (July, 1961).
The elasticity modulus of soap films as defined by Gibbs was measured for the first time. The method used involves simultaneous determination of the change in the surface tension acting upon a film under observation and of the motion of the interference fringes which this produces. The force acting upon the film is determined as part of the total force acting upon a vertical frame supporting this film in contact with the solution. The changes in surface tension are produced by rapidly withdrawing another film-forming frame from the solution, thus increasing greatly the total surface. The motion of the fringes is recorded photographically and is then translated into the motion of the surface elements on the assumption that the volume of liquid within the film remains constant. Details and limitations of this procedure are discussed. For a number of mobile films with the modulus of elasticity is of the order of 10 dynes/cm, while for a rigid film of sodium lauryl sulphate-lauryl alcohol solution it is of the order of 100 dynes/cm. This provides evidence for another factor in the well-known stabilizing effect of lauryl alcohol upon sodium lauryl sulphate foams.

15829 THE STABILITY OF INVERSE BUBBLES. M.H.I.Baird.
Trans Faraday Soc. (GB), Vol. 56, Pt 2, 213-19 (Feb., 1960).
Inverse bubbles of diameter 0.1-2.0 cm were formed in aqueous solutions of surface-active agents. The rate of decrease of the air-film thickness at the base of the bubble was observed by an interference method. Agreement was obtained with a theoretical equation based on a mechanism of viscous drainage of air between rigid liquid surfaces. Deviations from the theory are explained as due to the mobility of the liquid surface. Coalescence of the inverse bubbles depends on two factors: (i) random shocks, to which the larger bubbles are very susceptible and (ii) a minimum air-film thickness which limits the lifetimes of the smaller bubbles. The minimum air-film thickness is about 3000 A. It is concluded that Van der Waals forces make the air films unstable at this thickness. Long-chain ions have only a slight stabilizing effect, in contrast to published findings for aqueous films in air.

15830 RADIO-TRACER TECHNIQUES FOR THE STUDY OF FLOW IN SATURATED POROUS MATERIALS.
H.E.Skibitzke, H.T.Chapman, G.M.Robinson and R.A.McCullough.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 1, 38-46 (Feb., 1961).
An experiment was conducted by the U.S. Geological Survey to

determine the feasibility of using a radioactive substance as a tracer in the study of microscopic flow in a saturated porous solid. A radioactive tracer was chosen in preference to dye or other chemical in order to eliminate effects of the tracer itself on the flow systems such as those relating to density, viscosity and surface tension. The porous solid was artificial "sandstone" composed of uniform fine grains of sand bonded together with an epoxy adhesive. The sides of the block thus made were sealed with an epoxy coating compound to ensure water-tightness. Because of the chemical inertness of the block it was possible to use radioactive phosphorus (P^{32}). Ion-exchange equilibrium was created between the block and nonradioactive phosphoric acid. Then a tracer tagged with P^{32} was injected into the block in the desired geometric configuration, in this case, a line source. After equilibrium in isotopic exchange was reached between the block and the line source, the block was rinsed, drained and sawn into slices. It was found that a quantitative analysis of the flow system may be made by assaying the dissected block.

15831 RADIOACTIVE TRACERS FOR MEASURING THE PERIODS OF RETENTION IN PERCOLATING FILTERS. G.E.Eden and K.V.Melbourne.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 172-8 (Oct., 1960).

The period of retention of liquid in a laboratory-scale percolating filter was determined using six radioactive tracers and one chemical tracer. Of the radioactive tracers it was found that adsorption of Na^{24}, Rb^{86} and K^{42} was too great for them to be of use. With bromide-Br^{82}, tritiated water and cobalticyanide labelled with Co^{58} or Co^{60}, more satisfactory results were obtained. Of these tracers, cobalticyanide appeared the most suitable, taking into account half-life, adsorption and ease of counting.

15832 THE DRAINAGE OF LIQUIDS FROM POROUS MATERIALS. E.G.Youngs.
J. geophys. Res. (USA), Vol. 65, No. 12, 4025-30 (Dec., 1960).

An equation is derived to describe the yield of liquid at a given time from a freely draining column of initially saturated porous material in a gravitational field by using a capillary tube model. The equation is supported by experimental evidence.

15833 SINGULARITY DISTRIBUTIONS FOR THE ANALYSIS OF MULTIPLE-FLUID FLOW THROUGH POROUS MEDIA. G.de Josselin de Jong.
J. geophys. Res. (USA), Vol. 65, No. 11, 3739-58 (Nov., 1960).

The simultaneous flow of fluids of different properties is treated by substituting these fluids by one hypothetical fluid and applying singularities at those points where the properties of the actual fluids change. Their magnitude is chosen so that the specific discharges in the hypothetical fluid are everywhere identical to the specific discharges in the actual fluids. The flow in the hypothetic fluid can be determined by potential theory from the transformed boundary conditions and the influence of the singularities. For the determination of the discharge, a stream function is used which contains singularities in the form of vortices. For the determination of the fluid pressures a multiple-fluid potential is defined which contains singularities in the form of source and sink distributions. The stream and the potential functions each combine with auxiliary, many-valued functions to form complex potentials. These permit solutions in the form of one integral in complex variables, valid for any point in the entire field, irrespective of the fluid present. The solution for the transition zone between fluids as well as the abrupt interface is elaborated. The two-dimensional example of an infinite, confined aquifer with an initial vertical interface between two fluids of different specific weight is elaborated, giving as a result the movement of the fluids in the entire field at the first moment and a first approximation for the rotation of the interface around the centre as a function of time. These results are verified by a parallel plate model and an electric resistance model. In the latter model the vortices are replaced by sources for the tracing of streamlines and by source-sink combinations forming doublets for the potential lines.

15834 ON THE TENSOR FORM OF DISPERSION IN POROUS MEDIA. J.Bear.
J. geophys. Res. (USA), Vol. 66, No. 4, 1185-97 (April, 1961).

The variance of the bivariate normal distribution, which approximately defines the concentration distribution resulting from a tracer point injection into a uniform field of flow in a porous medium, is a second-rank tensor. When a point injection is subjected to a sequence of uniform movements in various directions, the final concentration distribution can be obtained by a summation of the corresponding to the various movements. The concentration ution across a transition zone, which develops when an abrupt face between two miscible fluids is subjected to a sequence of form movements, can be determined by integrating the result single point injection over the entire tracer region. The prop isotropic porous media to disperse a tracer fluid is defined b constant of dispersion which is shown to be a fourth-rank ten If the displacement is defined as a second rank tensor, the va of the distribution is obtained by the product of twice the cons dispersion and this displacement tensor.

15835 STUDY OF THE CIRCULATION OF PARTICLES FLUIDIZED BED. G.A.Donnadieu.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 53, 295-300 (Dec In French.

A study is made of the convection of heat between fluid a at the entry region of a fluidized bed where the heat transmis rate is high. A coefficient of thermal conduction (Λ), termed conductibility", is defined from which a thermal diffusivity (A derived for the fluidized bed. A theoretical expression is de for (A) at the entry region and proved by limited experimenta on a glass bead/air suspension; the variation of this paramet particle size and mass flow is also reported. This is conside be the only quantitative assessment of this parameter made s 3 refs. J.W.

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

15836 DETERMINATION OF THE DENSITY OF LIQUIDS AND THEIR SATURATED VAPOURS AS A FUNCT OF TEMPERATURE AT PRESSURES HIGHER THAN ONE ATMOSPHERE. I. MEASUREMENTS WITH AMMONIA.
J.Janik and J.A.Janik.
Acta phys. Polon. (Poland), Vc¹. 20, No. 8, 679-90 (1961).

15837 DETERMINATION OF THE DENSITY OF LIQUID THEIR SATURATED VAPOURS AS A FUNCTION TEMPERATURE AT PRESSURES HIGHER THAN ONE ATMO SPHERE. II. MEASUREMENTS WITH METHYL MERCAPTA $[CH_3SH]$. J.Janik and J.A.Janik.
Acta. phys. Polon. (Poland), Vol. 20, No. 8, 691-700 (1961).

15838 LIQUID CRYSTALS.
I.G.Chistyakov.
Kristallografiya (USSR), Vol. 5, No. 6, 962-76 (Nov.-Dec., 196 In Russian.

Review, with reference to 70 published contributions. [E translation in: Soviet Physics—Crystallography (USA), Vol. 5 917-30 (May-June, 1961)].

DISSOLUTION SHAPES OF SPHERICAL SHELL CRYSTA
See Abstr. 14984

THE RELATIONSHIP BETWEEN THE DISSOLUTION SHA AND SOLUTION ANISOTROPY IN CUBIC CRYSTALS.
See Abstr. 14982

15839 INTERPRETATION OF ABSOLUTE MEASUREME OF X-RAY CENTRAL SCATTERING IN POINT A LINEAR COLLIMATION: SOLUTIONS OF GLOBULAR AND ROD-LIKE PARTICLES. V.Luzzatti.
Acta cryst. (Internat.), Vol. 13, Pt 11,939-45 (Nov., 1960). In French.

An experimental device is described for recording X-ray small-angle scattering on an absolute scale. Theoretical cal tions are developed which permit the determination of severa structural parameters for the cases when the sample is a sol of (1) globular and (2) rod-like particles. Both point and line collimations are considered.

15840 PECULIARITIES OF THE X-RAY SCATTERING INTENSITY CURVES AND OF THE CURVES OF A DISTRIBUTION IN LIQUID METALS (REVIEW).
I.V.Radchenko and I.M.Shapovalov.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 5-16 (1959). In Ukrai

he intensity curves of liquid Hg, In, Tl, Pb and Au are
ared with each other and with the theoretical Prins's curve
e diffuse f.c.c. lattice; next the intensity curves for metals
ody-centred lattice (Li, Na, K) are compared with those for
s with a diffuse body-centred lattice. The results of these
arisons show that all liquid metals have a tendency to the
packing of atoms, and that after fusion there remain some
s of the order which existed in the solid state. The analysis
curves of atom distribution enables one to represent
natically the arrangement of atoms as a few atom layers
g a density higher than the mean density and separated by
s whose density is lower than the mean one. F.Lachman

841 SCATTERING OF SLOW NEUTRONS BY LIQUID HYDROGEN. G.Sarma.
ys. Radium (France), Vol. 21, No. 11, 783-8 (Nov., 1960).
ench.
The differential scattering cross-section is expressed, under
reasonable assumptions, as a product of two factors of
le physical meaning. The first factor, through spin
elations, involves transitions between molecular states and
y leads to a kind of an angular dependent scattering length,
is computed exactly for every transition in the rigid rotator
oximation. The second factor depends only on the translational
on of the molecules, which turns out to be a Fourier transform
e pair correlation function for a monatomic liquid. It is
n that the "coherent" part of the scattering, i.e. the part
ving correlation between pairs of distinct molecules, is
gible. Thus the scattering is mainly related to the so-called
correlation function. Recoil appears naturally as a prominent
re. It is shown that the scattering is generally well described
eans of a perfect gas model, taking into account the recoil of
nolecules. This model leads to well-separated peaks at a
angle. The small angle elastic scattering, where the perfect
model is no longer valid, should allow for the measurement of
efficient of self-diffusion.

THE SCATTERING OF SUBTHERMAL NEUTRONS BY H_2O, D_2 AND C_6H_6. See Abstr. 13429

5842 DISCRETE SITES IN LIQUIDS.
G.W.Robinson.
cular Phys. (GB), Vol. 3, No. 3, 301-3 (May, 1960).
The structure of the 2537 A line of Hg dissolved in fluid argon
gh pressures indicates the presence of two kinds of site for Hg.
site is similar to that in the crystal, i.e. argon clusters have
nuclear distances and local density almost exactly as in the
l. It is suggested that a second site lies at the interface between
ters. R.F.Barrow

5843 A NEW APPROACH TO THE THEORY OF CLASSICAL FLUIDS. III. GENERAL TREATMENT OF CLASSICAL TEMS. T.Morita and K.Hiroike.
gr. theor. Phys. (Japan), Vol. 25, No. 4, 537-78 (April, 1961).
For Pt II, see Abstr. 10500 of 1961. A classical system
osed in a finite volume and acted upon by external forces is
ted in a general way. The main results, which may be applic-
to solids as well as to fluids, are as follows. Exact integral
itions are found for the one- and two-particle distribution
tions. Some thermodynamic functions are expressed in terms
ese distribution functions. It is shown that there exist variat-
l principles requring that the grand partition function is to be a
imum with respect to the variations in the one- and two-particle
ribution functions. Variational principles are found also for the
nholtz free energy. It is suggested that Mayer's theory of
densation (Abstr. 7813 of 1951) may in fact give the end point of
metastable gaseous state. It is pointed out that the hyper-netted
n approximation (Abstr. 2748 of 1961) has a meaning in solids as
l as in fluids.

15844 PRE-FREEZING PHENOMENA IN MOLTEN METALS.
E.McLaughlin and A.R.Ubbelohde.
ns Faraday Soc. (GB), Vol. 56, Pt 7, 988-93 (July, 1960).
Pre-freezing phenomena in the viscosities of molten tin and
c are examined in terms of the theory of cluster formation in the
lts. It is shown that the existence of aggregates of atoms permits
erpretation of the anomalous viscosity on approaching the freezing
nt.

15845 COORDINATION NUMBER AND THE STRUCTURE OF LIQUID METALS. Ya.I.Dutchak.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 6, 888-91 (June, 1960). In Russian.
It is shown analytically that the structure of a liquid metal is not determined by its coordination number which, however, affects the degree of perfection of the "lattice" characteristic of a given liquid metal. M.H.Sloboda

15846 STATISTICAL MECHANICS OF SOLID AND LIQUID MIXTURES OF ORTHO- AND PARA-HYDROGEN. II.
A.Babloyantz and A.Bellemans.
Molecular Phys. (GB), Vol. 3, No. 4, 313-18 (July, 1960).
For Pt I, see Abstr. 8060 of 1959. Various refinements are added to the previous theoretical calculation of the configurational free energy of condensed mixtures of o- and p-hydrogen, based on an oversimplified statistical model: (a) account is taken of the fact that the forces acting between o- and p-molecules are somewhat different and (b) the rigid lattice model previously used is replaced by an ensemble of Einstein oscillators. A better agreement with experiment is reached.

15847 A TEST OF THE LENNARD-JONES POTENTIAL FOR NITROGEN AND METHANE. J.S.Rowlinson.
Molecular Phys. (GB), Vol. 3, No. 3, 265-9 (May, 1960).
The experimental behaviour of the classical fluctuation discriminant of the configurational energy and the virial is examined for the fluid states of nitrogen and methane. This discriminant must be essentially positive. It is found that the assumption of a Lennard-Jones 12 : 6 potential leads to negative values of the discriminant for the orthobaric liquids at low temperatures, for the liquids at high pressures, and, probably, for the gases at high temperatures. These results conform those found previously for argon, and demonstrate the inadequacy of the 12 : 6 potential at high densities and temperatures.

15848 TRANSPORT PHENOMENA IN POLYMER MEMBRANES. Y.Kobatake.
Suppl. Progr. theor. Phys. (Japan), No. 10, 226-39 (1959).
"Relaxation phenomena of Polymers" Meeting, Kyoto, 1958 (see Abstr. 6449 of 1961). The various transport phenomena which occur are schematically shown, and theoretical equations for them derived, viz., for electrokinetic effects, concentration membrane potentials, ionic permeability, osmosis, thermal diffusion and thermomembrane potential. Comparisons with current theories are made. The validity of the equations is established by means of experimental data. It is noteworthy that in living membranes the permeation rates of Na^+ and K^+ are considerably different. There are 16 refs. H.H.Hodgson

15849 THERMAL CONDUCTIVITY OF SIMPLE MOLECULES IN THE CONDENSED STATE.
J.K.Horrocks and E.McLaughlin.
Trans Faraday Soc. (GB), Vol. 56, Pt 2, 206-12 (Feb., 1960).
A model for the thermal conductivity of a liquid composed of spherically symmetric molecules is proposed. The theory permits calculation of the coefficient of thermal conductivity from the density, provided the force constants of the molecular interaction are known. The relative magnitude of "convective" and vibrational contributions is examined and the former is shown to be negligible. Calculated coefficients of thermal conductivity, for simple liquids, agree on average within approximately 20% of experimental values. The theory has also been applied to solids composed of similar molecules.

15850 ON THE SUPERHEAT OF LIQUIDS.
D.B.Sinha and A.K.Jalaluddin.
Indian J. Phys., Vol. 35, No. 6, 311-18 (June, 1961).
A new method for measuring maximum superheat temperatures of liquids was devised. A thin-walled degassed pyrex glass bulb, set vibration free and dipped in liquid, was heated by a coil immersed in Hg filling the bulb. This heating surface was chosen because it introduced minimum heterogeneity at the liquid–solid interface. The temperature of the liquid bulk was kept close to the boiling point using a paraffil oil bath. The temperature of the heater surface was increased in regular steps and the temperature at which the boundary film of the liquid exploded with vigorous ebulliton was taken as the maximum superheat temperature of the liquid. Results obtained with carbon tetrachloride, chloroform, acetone, benzene, methyl alcohol, carbon disulphide, diethyl ether,

n-pentane and ethyl bromide were compared with the values obtained by Kenrick, Gilbert and Wismer (1924) as well as with those deduced from Van der Waals equation. The agreement is fair. The set-up seems to offer a practical method for studying the effect of varying the nature of the interface on the superheat of liquids.

15851 CONCERNING THE MECHANISM OF DIFFUSION IN LIQUIDS. R.A.Swalin.
Acta metallurgica (Internat.), Vol.9, No. 4, 379 (April, 1961).

Further evidence is presented in support of a previous theory of liquid metal diffusion (Abstr. 14631 of 1960). The value of the r.m.s. jump distance calculated from the theory agrees well with that derived from an experimental value of the activation volume for self-diffusion in Hg. Also more recent determinations of D_0 and Q for liquid Sn are in good agreement with the theoretical estimates for these quantities. J.W.Taylor

15852 DIFFUSION COEFFICIENT AND FRICTION IN A GENERAL TWO-COMPONENT FLUID. O.Lamm.
Trans Faraday Soc. (GB), Vol. 56, Pt 6, 767-9 (June, 1960).

Although analytical proofs are to be preferred, the frequent use of induction in the fundamental theory of diffusion made it seem desirable to the author to link this method with common procedure (e.g. acceptance of Fick's law) in order to obtain a new derivation of the general relation between diffusion coefficient and component friction.

15853 THE MECHANISM OF THERMAL DIFFUSION IN LIQUIDS. V.B.Fiks.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 994-7 (March, 1961). In Russian.

Various relations between the properties of liquids are invoked; these are partly taken from the literature and partly put forward by the author. They are plausible but cannot claim any high accuracy. By combining these relations an estimate of the coefficient of thermal diffusion (Soret coefficient) is made and found to be equal to the reciprocal absolute temperature. This crude but simple estimate is compatible with experimental results. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 724-6 (Sept., 1961)]. R.Eisenschitz

15854 THERMAL DIFFUSION COEFFICIENT OF POLYSTYRENE IN TOLUENE.
C.L.Herren and J.S.Ham.
J.chem. Phys. (USA), Vol. 35, No. 4, 1479-80 (Oct., 1961).

A moving boundary technique was used to measure the thermal diffusion coefficient for polystyrene in toluene as a function of molecular weight. An almost constant value of 1.5×10^{-7} cm^2 $mole^{-1}deg^{-1}$ was obtained except below a molecular weight of 300 000 where a much smaller figure was found. This result agrees with the theory of Ham (Abstr. 19102 of 1960) but disagrees with earlier measurements of Hoffman and Zimm.

15855 SELF-DIFFUSION IN LIQUID AMMONIA.
D.W.McCall, D.C.Douglass and E.W.Anderson.
Phys. of Fluids (USA), Vol. 4, No. 10, 1317-18 (Oct., 1961).

The coefficient of self-diffusion for liquid ammonia was measured by proton magnetic resonance, spin-echo technique at -33° to -78° C. Data are recorded as an Arrhenius plot, the activation energy being 2.06 kcal./mole, $D = (4.44 \times 10^{-3})$ exp $(-1038/T)$. Values of Stokes—Einstein radius, viscosity, and jump length are also given. J.W.Taylor

DIFFUSION IN FUSED NITRATES. See Abstr. 15199

15856 SOME PROBLEMS ASSOCIATED WITH THE DEFINITION OF THE HEAT OF TRANSFER FOR BINARY LIQUID SYSTEMS. H.J.V.Tyrrell.
Trans Faraday Soc. (GB), Vol. 56, Pt 6, 770-5 (June, 1960).

The term "heat of transfer" has not in the past been used consistently either in non-equilibrium thermodynamics, or in relationship to the experimental quantity, the Soret coefficient, or in discussions of its connection with other molecular properties of liquids. A thermodynamic treatment introducing a heat of transfer comparable with that originally proposed by Eastman (1926-8) is briefly outlined and used to show the relationships between the Soret coefficient, the heat of transfer, and activity coefficient terms defined on the molal and mole fraction scales. The results of this are used to illustrate the similarities and differences between the available theories of the heat of transfer in binary liquid systems.

15857 THE RATE OF ATTAINMENT OF SORET EQUILI J.N.Agar.
Trans Faraday Soc. (GB), Vol. 56, Pt 6, 776-87 (June, 1960).

Equations giving the rate of change of concentration durir thermal diffusion in 2-component liquid systems are develope starting from the usual form of Fick's law and avoiding the ambiguities in the specification of frames of reference and diffusion coefficients that occur in earlier treatments. Volum changes during non-isothermal diffusion (with steady tempera are also considered and shown to be negligible under ordinary conditions. A simplified diffusion equation, valid for small temperature intervals, is derived and solutions are given in t "trigonometric" and in the less familiar "error function" forr the latter are convenient for short times. Corrections arisin from changes in the temperature gradient during the "warmin period at the beginning of a thermal diffusion experiment are evaluated; they are small but not always negligible.

15858 NOTE ON THE BOILING POINTS AND SURFACE TENSIONS OF BINARY MIXTURES OF ACETONE ISOPROPANOL. P.K.Katti and M.M.Chaudhri.
J. chem. Phys. (USA), Vol. 35, No. 2, 756-7 (Aug., 1961).

Experimental data are given. They are found to be repre respectively by the corresponding quasi-crystalline relations these properties.

15859 THERMODYNAMIC FUNCTIONS FOR MIXING AT "CONSTANT VOLUME". R.L.Scott.
J. phys. Chem. (USA), Vol. 64, No. 9, 1241-7 (Sept., 1960).

In interpreting the thermodynamic functions for mixing n electrolyte liquids, experimentally determined at constant pr (process I), it is frequently useful to correct these to "consta volume". However there are several different constant volun cesses. Two of these, a "constant volume—equal initial pres process" (II) and a "constant molecular concentration proces (III) are examined carefully; the appropriate functions may be culated from those of process I and properties of the pure co ents only. Constant volume functions for both II and III are c ted for seven binary systems of various kinds including two h carbon + fluorocarbon mixtures. Process III is that suggeste lattice theories of solutions. However, whenever the differen between the molar volumes of the pure liquids is significant, numbers computed are not susceptible to simple interpretatio Both this process and the lattice model appear to be rather a Process II, while not completely justified by any theoretical t ment, appears to be the more interesting. For many simple the entropy of mixing for process II is approximately ideal (w 0.1R per mole). For these systems the excess entropy in the stant pressure process appears to be largely a result of the v expansion or contraction on mixing.

15860 VOLUME CHANGE ON MIXING IN LIQUID SODIU POTASSIUM NITRATES.
J.L.Katz, B.F.Powers and O.J.Kleppa.
J. chem. Phys. (USA), Vol. 35, No. 2, 765-6 (Aug., 1961).

By giving greater attention to the purging of dissolved ga from the fused salts, greater precision was obtained in the de mination of this volume change. It was found that the maximu value of the excess volume is about $\pm$ 0.07 cm^3/mole and is in dent of the temperature in the range investigated (350°-425° C values of the excess volume are expressible by means of a pa equation of the usual form $\Delta V^M = X(1-X)A$ where X = the mol fraction of one component and A is a constant. The volume a (previously determined) enthalpy data for this system demons that a satisfactory theory for these mixtures must be second or higher.

15861 INTERNAL PRESSURE AS THE BASIS OF A THE OF SOLUTIONS. C.V.Suryanarayana.
J. sci. industr. Res. (India), Vol. 20A, No. 3, 141-4 (March, 19

A theory of solutions applicable to weak and concentrated of electrolytes and non-electrolytes is proposed based on the dependence of viscosity and electrical conductivity on interna pressure: the latter is calculated from the density and molecular weight of the solvent or solution. From the variati viscosity with temperature and concentration, a close interre ship between this property and internal pressure is establish a number of systems, this relationship being exponential in fo The interdependence of electrical conductivity and internal pr for these systems is also established satisfactorily. J.W.

862 A SIMPLE MODEL OF AQUEOUS SOLUTION OF STRONG ELECTROLYTE. T.Satoh.
ys. Soc. Japan, Vol. 15, No. 6, 1134-5 (June, 1960).
supposes a primary and a secondary hydration region unding each ion, and is claimed to account for the variation of ctric relaxation wavelength as a function of the electrolyte ntration. W.Good

863 THE SOLUTION PROCESS OF CALCITE IN AQUEOUS SOLUTIONS OF CHLORIDES AT HIGH TEMPERATURES N PRESSURES N.Yu.Ikornikova.
allografiya (USSR), Vol. 5, No. 5, 761-9 (Sept.-Oct., 1960).
ssian.
The solution of calcite in aqueous solutions of NaCl, LiCl, $CaCl_2$, l was studied at 350-500° C and 100-1800 atm. [English trans- in: Soviet Physics—Crystallography (USA), Vol. 5, No. 5, 1 (March-April, 1961)].

864 ROTATIONAL MECHANICAL MOMENTS OF ELECTROLYTE SOLUTIONS IN A ROTATING HIGH-QUENCY ELECTRIC FIELD. E.Grossetti.
Cimento (Italy), Vol. 21, No. 3, 395-400 (Aug. 1, 1961).
Electrolyte solutions placed in a rotating high-frequency .00 Mc/s) electric field showed remarkable rotational moments, ugh in this frequency range the theory of the torque depending e conductivity does not predict any effect. The measurements made against the dilution (defining the dilution as the inverse concentration and expressing it in dm^3/g-eq). While the ctivity Δ of such solutions, for dilutions of the order of Ω^{-1} cm^{-1}(g-eq)l^{-1}, acquires a value which practically does not ge with the dilution, the torque due to the presence of dipoles tends to increase even when the dilution reaches values of the r of 10^3 Ω^{-1} cm^{-1}(g-eq)l^{-1}. Furthermore it is shown that the ue is proportional to the square of the electric field. The ndence of this moment on the frequency is characteristic of solution.

865 STUDY OF THE HYDRATION—DEHYDRATION IN POLYELECTROLYTE SOLUTIONS BY THE RASONIC TECHNIQUE. H.Asai.
ys. Soc. Japan, Vol. 16, No. 4, 761-6 (April, 1961).
The ultrasonic velocity and the density of the polycarboxylic solutions which are neutralized at various degrees by sodium oxide or tetra-n-butyl ammonium hydroxide were measured. n these results, the amount of hydrated water molecules was nated. An abnormal behaviour of hydration was found in poly- solutions neutralized by NaOH, which is interpreted as being o the partial dehydration resulting from Na ion—polyion binding high degree of neutralization. The effects of adding various - or di-valent salts upon the hydration state of polyanion were examined. From these experiments, it was found that Ba -polyion binding gives rise to 40% dehydration of the water ecules which are hydrated in no binding state, and Mg ion—poly- inding gives rise to 20% dehydration. The results in polyacids compared with the results in monoacids, and it is concluded the above dehydration phenomenon is one of the important acteristics of polyacids.

5866 THE ANOMALOUS TEMPERATURE DEPENDENCE OF SOUND VELOCITY IN WATER. J.Schuyer.
ecular Phys. (GB), Vol. 3, No. 6, 597-9 (Nov., 1960).
The increase in velocity is described by introducing a perature-dependent attraction term into the inter-molecular ntial energy function. This leads to the relation

$$\frac{1}{v}\cdot\frac{dv}{dT} = \frac{n+7}{6}\cdot\frac{1}{\rho}\cdot\frac{d\rho}{dT} + \frac{7}{2n-12}\cdot\frac{x}{T}$$

re x is given by

$$\frac{a_1}{a_2}\cdot T = \frac{1-x}{x}.$$

derivation of a_1 and a_2 is given and presents a further inter- tation. Values of x computed from the two equations for water for liquid ammonia and hydrogen fluoride show good agreement. conclusion is that the anomaly is due to a low thermal ansion coefficient. J.D.Rands

15867 EFFECT OF ALCOHOL IMPURITY ON ULTRASONIC VIBRATIONAL RELAXATION IN LIQUID CS_2.
W.M.Slie and T.A.Litovitz.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1412-17 (Oct., 1961).
Ultrasonic attenuation measurements were made in liquid carbon disulphide—alcohol mixtures over a frequency range from 5 to 155 Mc/s at a temperature of -63° C. From these measurements the vibrational relaxation frequency for the liquid was calculated. Methyl, propyl, and butyl alcohol were added in various concentrations up to 0.6 mol.%. In every case the relaxation frequency increased with the addition of the impurity. This increase was found to be a linear function of the impurity concentration which is consistent with the assumption that the vibrational translational energy transfer is a binary collision process. The shifts in relaxation frequency per mol.% of impurity were found to be a linear function of the molecular weight of the impurity molecules for both the gas and liquid data. A comparison was made of the ratio of collision efficiency of like to unlike molecules in both the gas and liquid state. It was found that within experimental error this ratio is the same in both states. This was interpreted as meaning that the vibrational relaxation process for unlike collisions was the same in both liquids and gases. Further, it appears the the efficiency of an AB-type collision is more strongly temperature dependent than for the AA-type collisions.

15868 MOLAR SOUND VELOCITY IN INORGANIC MELTS AND SOLUTIONS.
S.V.Subrahmanyam and J.Bhimasenachar.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1447-9 (July, 1961).
From an examination of the available ultrasonic and density data, in the case of eleven inorganic melts, the relation between the molar volume (M/ρ) and sound velocity, V, is found to be

$$MV^{2/3}/\rho = S$$

where S is a constant independent of temperature. The molar sound velocity S is found to be an additive property. The contributions of different ions to the molar sound velocity of a liquid are evaluated. The variation, of $V^{2/3}/\rho$ with percentage weight of the solute in aqueous solutions for a number of univalent electrolytes, is found to be linear. The linear plots are extrapolated to get the value of $V^{2/3}/\rho$ for 100% of the solute. These values are multiplied by the respective values of the molecular weights of the solutes to give the molar sound velocity for the substance. Such extrapolated values are found to correspond to the molar sound velocity of the substance in the liquid phase.

15869 MOLAR SOUND VELOCITY IN MOLTEN HYDRATED SALTS. P.R.K.L.Padmini and B.Ramachandra Rao.
Nature (GB), Vol. 191, 694-5 (Aug. 12, 1961).
The variation of ultrasonic velocity with temperature over the range 60-100° C was studied for the molten hydrated salts lead acetate, sodium acetate, sodium potassium tartrate, aluminium nitrate and calcium nitrate; the results are presented graphically. Rao's relation (Abstr. 3183 of 1940) is found to hold despite some unusual variations. L.Mackinnon

15870 ULTRASONIC ABSORPTION IN AQUEOUS ELECTROLYTE SOLUTIONS.
B.Ramachandra Rao and H.S.Rama Rao.
J. sci. industr. Res. (India), Vol. 20B, 93-5 (March, 1961).
The variation of ultrasonic absorption with concentration was investigated in aqueous solutions of 14 electrolytes. $Pb(C_2H_3O_2)_2$, $NH_4C_2H_3O_2$, $NaC_2H_3O_2$, $MnC_2H_3O_2$, $Co(C_2H_3O_2)_3Pb(NO_3)_2$, $Ba(NO_3)_2$, KBr, KI, $CoCl_2$, $CoBr_2$, $BaCl_2$, $BaBr_2$ and $MgSO_4$ at a frequency of 16.1 Mc/s; the method followed is that of Towle and Lindsay (Abstr. 6823 of 1955). It was observed that (1) the magnitude of absorption is generally lower in the case of 1-1 valence type of electrolytes compared to 2-1 valence type electrolytes, and (2) that for the halide solutions investigated, for a fixed positive radical, increase in atomic weight of the negative radical tends to decrease absorption, although this not evident in the case of $BaCl_2$ and $BaBr_2$. These results are in general agreement with those of earlier workers for corresponding electrolytes.

15871 ULTRASONIC VELOCITY IN AQUEOUS SOLUTIONS OF SOME ELECTROLYTES.
M.G.Seshagiri Rao and B.Ramachandra Rao.
Nature (GB), Vol. 191, 164 (July 8, 1961).
Contrary to the normal behaviour exhibited by aqueous solutions,

calcium iodide, zinc bromide, silver nitrate and cerous acetate solutions show a nonlinear decrease of ultrasonic velocity with increase in concentration. The data for calcium iodide and zinc bromide fit the electrolyte theory of earlier investigations (see, for example, Abstr. 140 of 1959; 16769 of 1960), but the irregular behaviour of silver nitrate and cerous acetate, though recorded as interesting, is not explained. J.D.Rands

15872 INVESTIGATION OF THE VELOCITY OF ULTRASOUND IN SOME POLYSILOXANES.
A.Z.Golik and P.F.Cholpan.
Akust. Zh. (USSR), Vol. 7, No. 1, 33-9 (1961). In Russian.

The temperature dependence of the velocity of sound and adiabatic compressibility was investigated in linear and cyclic polymethyl- and polyethylsiloxanes and their mutual solutions, including isoviscous solutions. The velocity of sound varies linearly with temperature (departing from linearity near the pressure point); the adiabatic compressibility varies exponentially with temperature. It is shown that in a group of substances similar in structure, the curves for the temperature dependence of β_a are lower the greater the intermolecular potential. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 23-8 (July-Sept., 1961)].

15873 THE PROPAGATION OF ULTRASONICS IN ORGANIC LIQUIDS UNDER PRESSURE. VARIATION OF SPECIFIC HEAT RATIO AND VISCOSITY WITH PRESSURE.
H.F.Eden and E.G.Richardson.
Acustica (Internat.), Vol. 10, No. 5-6, 309-15 (1960).

Measurements of velocity and attenuation of u.s. pulses in a number of organic liquids at pressures up to 10 000 lb in^{-2} are reported, using an apparatus previously described (Abstr. 1475 of 1960). By comparing the deduced adiabatic compressibility with the known isothermal compressibility the ratio of specific heats as a function of pressure for each liquid is determined. The absorption coefficient is measured in four liquids over the same range of pressure.

15874 ULTRASONIC ABSORPTION OF POLYMER SOLUTIONS.
G.Gooberman.
Nature (GB), Vol. 191, 693-4 (Aug. 12, 1961).

An alternative explanation to that of Wada and Shimbo (Abstr. 5343 of 1953) is provided by a viscosity argument for the enhanced absorption of ultrasound by polymethylmethacrylate in benzene–methylmethacrylate solutions; experiments with 5.19 Mc/s ultrasound at 26° C are described which give partial support to the argument. L.Mackinnon

15875 THE VERIFICATION OF THE THEORY OF THE ORIENTATION OF RIGID PARTICLES BY BIREFRINGENCE DURING FLOW. J.Leray.
J. Chim. phys. (France), Vol. 58, No. 3, 316-21 (March, 1961).
In French.

Tobacco mosaic virus was used in an attempt to verify the theory of the Maxwell effect, for rigid particles in velocity gradients. The results obtained depart considerably from the theory. Since the theory was substantiated with other particles, the author considers that the optical arrangements may have affected the results. R.W.Fish

15876 A NEW TYPE OF PHENOMENON OF FLOW BIREFRINGENCE IN MACROMOLECULAR SOLUTIONS.
S.Fujishige.
Nature (GB), Vol. 189, 653 (Feb., 1961).

Graphs are given which show the variation of extinction angle and birefringence with gradient for solutions of methyl cellulose (Methocel), of molecular weight 140 000, in water and in a mixture of methyl alcohol and water. The results obtained for freshly made solutions and for solutions at least two months old were very different. It is suggested that this is due to inter- and intramolecular hydrogen bonds between exposed hydroxyl groups of the polymer chains suffering dehydration during ageing or by the addition of the alcohol. H.G.Jerrard

15877 VISCOSITY AND DYNAMIC BIREFRINGENCE OF FLEXIBLE MACROMOLECULES. A.Peterlin.
J. Phys. Radium (France), Vol. 22, No. 7, 407-11 (July, 1961).
In French.

Intrinsic viscosity and dynamic double refraction can be calculated for all values of the velocity gradient between 0 and ∞, in the case of an elastic dumb-bell, when, for a given velocity gradient, the mean values of intramolecular distances are introduced. Then the intrinsic velocity first decreases to a minimum value and then slowly increases with velocity gradient, because of progressi stretching of the supposed perfectly flexible macromolecule. Dynamic double refraction is less varying in this theory than simpler one which does not take into account the variation of hy dynamic interaction with the stretching of the macromolecule results obtained are valid only for infinitely long and perfectl flexible molecules.

15878 FLOW BIREFRINGENCE OF POLYMER SOLUTI
R.Koyama.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1366-76 (July, 1961).

By making use of a gaussian chain model for a polymer molecule, a theoretical calculation on the flow birefringence polymer solution is carried out, in which the optical internal in the polymer molecule in a solvent is taken into account. T expression obtained for the intrinsic birefringence contains a quadratic form of the refractive index of the solvent, and this account for several experimental results. The expression fo intrinsic extinction angle also has a certain optical factor, an thus it predicts that the extinction angle depends on the refra index of the solvent. Assuming that there is no hydrodynamic action between molecular segments, some numerical calculat were carried out on the optical factors. The result can well reproduce the recent experimental values of polystyrene mol and of the polymethylmethacrylate molecules.

15879 VARIATION OF THE INTENSITY OF RAMAN LIN WITH TEMPERATURE. B.Moszyńska.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 323-5 (1961). In French.

The Raman lines of $SiCl_4$ and $TiCl_4$ show, for liquid speci decreasing intensity with increasing temperature. This anom result is attributed to intermolecular interactions; it is not fo for CCl_4 where the polarity of the bonds is small. G.F.I

15880 INTENSITY STUDIES IN RAMAN EFFECT: EFF OF TEMPERATURE. I. (LIQUIDS).
K.Venkateswarlu and K.Ramaswamy.
Z. Phys. (Germany), Vol. 163, No. 4, 457-62 (1961).

The influence of temperature on the intensities of the Raman lines in some polar and nonpolar liquids is investigat

15881 INTENSITY STUDIES IN RAMAN EFFECT: EFFECT OF TEMPERATURE. II. (ASSOCIATIV LIQUIDS AND MOLTEN SUBSTANCES).
K.Venkateswarlu and K.Ramaswamy.
Z. Phys. (Germany), Vol. 163, No. 4, 463-6 (1961).

The influence of temperature on the intensities of Raman lines in some associative liquids and molten substances is studied and the observed temperature dependence is explaine on the basis of intermolecular interactions.

15882 LOW-FREQUENCY INFRARED ABSORPTION SP RUM OF THE HYDROGEN BOND IN LIQUID WAT AND IN CRYSTAL HYDRATES. A.E.Stanevich and N.G.Yaro
Dokl. Akad. Nauk SSSR, Vol. 137, No. 1, 60-3 (March 1, 1961)
In Russian.

The structure of a broad infrared absorption band of ligh heavy water is discussed. Besides frequencies found experi a number of frequencies calculated for the possible vibration energies of molecular bonds are also given. The latter contr to the general shape of the broad band. The absorption spect number of compounds containing water of crystallization were investigated. It was found that the bands disappear when the pound is heated to a high temperature. This is explained by attributing the discrete absorption bands to the water molecu weakly bound to the crystalline structure of the compound. A of frequencies of the absorption bands for all compounds exa is given, but no interpretation is attempted due to the comple of the vibrational states of these molecules. [English translat Soviet Physics—Doklady (USA), Vol. 6, No. 3, 224-7 (Sept., 19 W.G.

15883 LIGHT ABSORPTION IN PARAMAGNETIC Co^{++} IN STATE OF SOLUTION
A.Mookherji and N.S.Chhonkar.
Indian J. Phys., Vol. 34, No. 7, 336-7 (July, 1960).

Measurements on about 15 cobalt salts in aqueous solutio absorption near 20 000 cm^{-1} split into 3 bands only; this sugg a very small tetragonal splitting Δ. G.F.

84 USE OF IDEALIZED RELAXATION SPECTRA IN THE INTERPRETATION OF EXPERIMENTAL RESULTS ERNING POLYMER SOLUTIONS. K.Walters.
.. Phys. (USA), Vol. 32, No. 10, 1975-8 (Oct., 1961).
e usefulness of a new representation of the relaxation of viscous liquids is discussed, and an idealized form of this um is used to interpret experimental results for polymer ons.

885 VIBRATIONAL SPECTRA OF INORGANIC MOLECULES. II. INFRARED REFLECTION SPECTRA IQUID LITHIUM, SODIUM, POTASSIUM, AND SILVER ATES. J.K.Wilmshurst and S.Senderoff.
m. Phys. (USA), Vol. 35, No. 3, 1078-84 (Sept., 1961).
or Pt I see Abstr. 4936 of 1961. The optical constants of lithium, sodium, potassium, and silver nitrates were ed by a one-angle-reflection method using the analysis of son and Price. The derived absorption spectra are consistent he Raman spectra observed by Bues and suggest that in all s the point group symmetry of the cations about the nitrate ion not contain D_{3h} as a subgroup. Further, in both lithium and r nitrate the highest symmetry subgroup common to the nitrate nd the surrounding cations is at most C_{2v} and in these melts trate ion is not rotating freely about its threefold axis. In all elts there is a low-frequency band which must be ascribed to ion-anion vibration of a lattice-like type. The intensity of the and is discussed and the bond dipole moment derived is preted in terms of the polarizing field of the cations.

886 MOLAR EXTINCTION COEFFICIENTS OF LIQUID O_3F_2, O_2F_2, AND O_3 IN THE VISIBLE RANGE. Kirshenbaum and A.G.Streng.
em. Phys. (USA), Vol. 35, No. 4, 1440-2 (Oct., 1961).
The absorption spectra for solutions of liquid O_3F_2, O_2F_2, O_3 in a Freon mixture of $CClF_3$ and CCl_2F_2, and that of d O_3 in liquid O_2 were measured at 77°K and their molar nction coefficients calculated. The effect of temperature on nolar extinction coefficient of liquid O_2F_2 in the Freon mix studied.

5887 INFLUENCE OF THE CONCENTRATION OF THE SOLUTE AND OF THE POLARITY OF THE SOLVENT THE ABSORPTION SPECTRA OF FLUORESCEIN. tsze and H.Waleryś.
. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), 9, No. 6, 507-13 (1961).
The influence of the polarity of the solvent and of the concen- on of the solute on the behaviour of particular fluorescein s in solution was investigated by means of visible and u.v. rption spectra. The intensities of different absorption bands observed to alter by different amounts as the dye concentra- was altered. The change was large for bands in the visible on and negligible for a band a 2780 A. The same changes e produced when the polarity of the solution was varied and dye concentration maintained constant. The intensity of the n bands was observed to decrease with decreasing polarity. se results were observed with solvents of relatively low rity. With higher polarity the spectral changes were found to nuch smaller. Analysis of the results suggests that in some ral solutions fluorescein is present mainly as anions and ral molecules. The chemical equilibrium between these two ns depends upon the dye concentration, the polarity and the perature and upon the original fluorescein modification used. inferred that the visible bands due to both univalent and lent anions are present. P.J.Dean

15888 INTERMOLECULAR ENERGY TRANSFER AND CONCENTRATION DEPOLARIZATION OF FLUOR- ENCE. A.Kawski.
. Phys. (Germany), Vol. 8, No. 1-2, 116-19 (1961). In German.
R_0, the critical molecular separation when the probability of ssion is equal to the probability of transfer of excitation energy, previously been calculated for fluorescein in glycerol and racene in Perspex (Abstr. 4423 of 1960). The corresponding ical concentrations C_0 for these solutions are 2.4×10^{-3} and $\times 10^{-2}$ mole/litre. Former experimental data on concentration olarization in these solutions are plotted for the above values of as relative fluorescence polarization against γ, where γ is the ncentration) $\times (1/C_0) \times$ (relative fluorescence yield)$^{1/2}$. The erimental results are shown to agree well with Förster's theory of concentration depolarization as modified by Ore (Abstr. 10805 of 1959). S.T.Henderson

15889 THE DURATION OF ULTRAVIOLET FLUORESCENCE OF CERTAIN AROMATIC COMPOUNDS.
T.V.Ivanova, O.I.Kudryashov and B.Ya.Sveshnikov.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 3, 572-4 (May 21, 1961). In Russian.
For abstract, see Abstr. 12888 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 407-9 (Oct., 1961)].

15890 QUANTUM EFFICIENCIES OF FLUORESCENCE OF ORGANIC SUBSTANCES: EFFECT OF SOLVENT AND CONCENTRATION OF THE FLUORESCENT SOLUTE.
W.H.Melhuish.
J. phys. Chem. (USA), Vol. 65, No. 2, 229-35 (Feb., 1961).
The absolute quantum efficiencies of fluorescence of de-aerated solutions of several organic fluorescent substances in petroleum ether (b.p. 60-80°), ethanol (99%) and benzene at 25° were measured with a rhodamin B quantum counter. An equation was derived for correcting the observed efficiencies of fluorescence for reabsorption of fluorescence and shifts in the region of absorption away from the quantum counter. Absolute quantum efficiencies of fluorescence extrapolated to zero concentration, bimolecular self-quenching constants and oxygen-quenching constants were measured at 25°. Quinine bisulphate, 5×10^{-3} M in 1 N H_2SO_4, is proposed as a standard with an absolute quantum fluorescence efficiency of 0.51 at 25°.

15891 THE INFLUENCE OF TARTARIC ACID ON THE PHOTOLUMINESCENCE OF DYE SOLUTIONS.
J.Głowacki.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 2, 113-18 (1961).
Studies were made of the absorption spectra and photolumines- cence intensity of dye solutions (eosin, rhodamine B and 6G, trypa- flavine and fluorescein) containing various concentrations of tart- aric acid. It is concluded that luminescence quenching of eosin by tartaric acid is due to chemical reactions, and that the quenching of other dyes depends on the molecular structure. J.B.Birks

ON THE DECAY PROCESSES OF POLARIZED PHOTOLUM- INESCENCE. See Abstr. 14650

15892 EXPERIMENTAL STUDIES ON SONOLUMINESCENCE AND ULTRASONIC CAVITATION. K.Negishi.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1450-65 (July, 1961).
Using a miniature spherical hydrophone made of barium titanate, the individual cavity collapse was detected as a sharp impulse (0.5 μs width) slightly after the pressure maximum of sound cycle. When many cavities collapsed simultaneously, the sinusoidal sound-pressure waveform was turned into a saw-tooth form. By comparing the flash of sonoluminescence with the instantaneous change of scattered light from cavitating bubbles in dark-field illumination, the sonoluminescence from water was found to occur during the final stages of the bubble collapse. The sonoluminescence from aqueous solutions of various sodium salts, organic solvents and luminol were also examined. The luminescence of luminol was applied in the development of a new method for the visualization of ultrasonic fields.

15893 EXPERIMENTAL INVESTIGATION OF THE SUMOTO EFFECT. W.F.Pickard.
J. appl. Phys. (USA), Vol. 32, No. 10, 1888-93 (Oct., 1961).
Examines the rising of a dielectric liquid along high-voltage electrodes dipped into it. Qualitative results are given for a number of different combinations of electrode material and liquid. The effects observed in the case of molybdenum-acetone systems excited by a low-frequency applied voltage are discussed in detail.

15894 EXTENSION OF STOKES' LAW FOR IONIC MOTION TO INCLUDE THE EFFECT OF DIELECTRIC RELAXATION. R.H.Boyd.
J. chem. Phys. (USA), Vol. 35, No. 4, 1281-3 (Oct., 1961).
The suggestion made by Fuoss [Proc. Nat. Acad. Sci. USA, Vol. 45, 807 (1959)] that dielectric relaxation induced by ionic motion in polar solvents contributes to the frictional force experienced by the ion is treated theoretically on a macroscopic basis analogous to the Stokes' law treatment of the conventional hydro- dynamic friction. An equation previously proposed by Fuoss on a semiempirical basis results from this treatment. Experimental

dielectric relaxation times are shown to lead to an effect of the proposed magnitude.

15895 THE INFLUENCE OF INDEPENDENT MOBILITY OF THE NH_2-GROUP IN ANILINE DERIVATIVES ON THEIR DIELECTRIC RELAXATION PROPERTIES. H.Kramer.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 974-9 (Nov., 1960).
In German.

Dielectric absorption is measured for aniline, seven methyl substituted anilines and o-, m- and p-chloro-anilines, in dilute benzene solution at 20° C, and wavelengths of 10.35, 3.06, 1.392 and 0.696 cm. Dipole moments are also determined by the solution-refraction method. The variation of absorption with wavelength is not described by a single Debye term, but use of two such terms, one ascribable to the motion of the whole molecule and the other to that of the group, gives satisfactory agreement. These terms, and corresponding relaxation times, are derived and compared for all the substances. The relaxation time for the whole molecule shows the Debye proportionality to molecular volume, with the Perrin relationship (Abstr. 96 of 1935) for non-spherical shape of the molecule. The partial dipole moments of the NH_2-groups are calculated from the theory of Budo (Abstr. 5037 of 1938), and are essentially constant, except for a small decrease on ortho-substitution. The angles between the NH_2-moments and the axis of the CN bond are also calculable, and are all close to 38°. The effects of substitution on the NH_2-group are therefore small.
J.Sheridan

15896 INTERPRETATION OF THE DIELECTRIC PROPERTIES OF GLYCOLS, COMPARISON WITH MONO-ALCOHOLS. Cl. Moriamez-Boullet.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 47-53 (1960).
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). An explanation is suggested for previous results on the permittivity and viscosity of polyalcohols. It is assumed that the O-atoms have unsaturated H-bonds, allowing H-bonding with the O-atoms of neighbouring chains. X-ray structure determinations are quoted in evidence. It is also assumed that the probability of rupture of an intramolecular bridge is less than that for an intermolecular one. Using these hypotheses it is possible to explain the values of the activation energies for the two dipole orientation processes and the viscous flow. Each dipole term corresponds to an H-bond rupture and the viscous flow to rupture of van der Waals or dispersion forces. An explanation is also possible of the differences between the magnitudes of the activation energies in the case of monoalcohols. Calculation of the Kirkwood g-factor is made for the model proposed and compared with experiment. Dissociation constants are calculated for the two cases of within-chain and between-chain dissociation. R.G.C.Arridge

15897 DIELECTRIC RELAXATION AND DIPOLE–DIPOLE INTERACTION. J.Sobhanadri.
Trans Faraday Soc. (GB), Vol. 56, Pt 7, 965-70 (July, 1960).

An attempt was made to evaluate dipole–dipole interaction energy from relaxation time measurements at microwave frequencies. Five trisubstituted benzenes — 2,6-dichlorotoluene, 2,4-dichlorotoluene, 3,4-dichlorotoluene, 2,4-dichloronitrobenzene, and 4-chloro-3-nitrotoluene — were investigated. Estimates of dipole interaction energy also obtained similarly from polarization measurements at 1 Mc/s led to much higher values.

15898 ASPECTS OF ELECTRICAL BREAKDOWN OF LIQUID INSULATING MATERIAL. II.
J.A.Kok and C.E.G.M.M.Van Vroonhoven.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 125-32 (1961).

For Pt I see Abstr. 4658 of 1959. Pt I is continued by considerations of the adsorption of soaps and resins on the impurities which float in the insulating liquid. It is shown that soaps and resins may stabilize the suspension, but if both are used in a certain proportion, immediate flocculation and lowering of the breakdown strength follow. The action of colloid chemical stabilizers or inhibitors, originating from research on dyes, is tentatively explained.

15899 ELECTRICAL CONDUCTIVITY AND CRYOMETRY OF SOLUTIONS OF FUSED SALTS. M.Bizouard.
Ann. Phys. (France), Vol. 6, No. 7-8, 851-911 (July-Aug., 1961).
In French.

An apparatus for the measurement of the conductivity of fused salts based on the potentiometric method for resistance is described with details concerning temperature control of the heating arrangements, the special cell employed, and the device for complete elimination of polarization phenomena. Data are reported for 14 solutions: KNO_3–$NaNO_3$, KNO_3–$LiNO_3$, KNO_3–$AgNO_3$, $NaNO_3$–$AgNO_3$. $NaNO_3$–$LiNO_3$, $LiNO_3$–$AgNO_3$, $AgNO_3$–$AgBr$, $AgNO_3$–$AgCl$, $AgCl$–KBr, $AgBr$–KCl, $AgCl$–$NaBr$, $AgBr$–Na $AgCl$–$LiBr$ and $AgBr$–$LiCl$. The cryometry of two-componen mixtures of the above halides of silver with those of the alkali metals, but without a common ion, are included. Three groups ionic salts are recognized viz., (1) mixtures of the nitrates of alkali metals and of silver; (2) mixtures of $AgNO_3$ with AgCl a AgBr respectively; and (3) mixtures of the halides of silver an the alkali metals not having a common ion. These conclusions supported by the cryometric data. Correlations are discussed between the electrical and thermal properties, size of ions, et the theory of crystal conductivity is applied to the data, and a of hypotheses on the structure of fused salts is submitted. The energy relations indicate that the reticular structure of the nit diminishes with temperature increase, whereas that of the hali remains unaffected. Suggestions on the nature of the factors r ponsible for conductivity are made viz., displaced cations for nitrates, and Schottky and Frenkel defects for the silver and a halides respectively. The two latter are furnished by calculati of the average distances between two adjacent defects. It is co cluded that fused ionic media preserve a reticular structure w is a function of the temperature and of the nature of each salt.
H.H.Ho

15900 MEASUREMENT OF THE RESISTIVITY OF CESIU AT ELEVATED TEMPERATURES. J.Hyman, Jr.
J. chem. Phys. (USA), Vol. 35, No. 3, 992-4 (Sept., 1961).

An experiment is described in which the electrical resisti of liquid caesium was measured from ambient temperature to 419° C, and experimental values are presented. In the low-temperature region the data agree quite well with measureme made by others. A linear approximation which best correlate data from the melting point to 419° C to ±1% is

$$\rho_{Cs} = 38.5[1 + 0.00308(T - 50)]\mu\text{ohm cm.}$$

Here T is temperature in degrees centigrade. By use of the Widemann–Franz relation, a thermal conductivity of 0.048 to cal/sec deg C cm is predicted.

ELECTRICAL-RESISTIVITY METER MONITORS OXYGEN CONTENT OF LIQUID METALS. See Abstr. 16209

15901 CONDUCTIVITY OF THE PROTON IN AQUEOUS SOLUTION. G.Perrault.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3779-81 (June 12,
In French.

An energy of activation suitable to any particular ion is in duced into the general dynamic equation for the conductivity o assembly of identical particles, and from it the variations of conductivity with temperature are deduced. Application of the results to pure water indicates that the proton participates in conductivity in nuclear form. The energy of activation may therefore be regarded as the energy of desolvation of the prot
H.H.Ho

15902 PROTONIC CONDUCTIVITY IN PURE WATER. G.Perrault.
C.R. Acad. Sci. (France), Vol. 252, No. 26, 4145-7 (June 26, 1
In French.

From the energy of activation of conductivity in pure wate (see preceding abstract), a nuclear protonic conductivity of $1{\cdot}55 \times 10^{-8}$ A is indicated below 25° C, on which, above 25° C, superposed a conductivity due to the solvated proton H^+4H_2O. It is concluded that the energy of cohesion of the latter is esse tially of electrostatic origin, and that its radius is 2·06 A.
H.H.Hod

15903 PHOTOEMISSION INTO LIQUID n-HEXANE. D.W.Swan.
Nature (GB), Vol. 190, 904-5 (June 3, 1961).

The photo-stimulation of conductivity in liquid n-hexane w examined for irradiation of the cathode with u.v. light. The ph current injected into the liquid as a function of applied field, f constant illumination from the back of a thin film cathode on t walls of the cell, was investigated. At low fields the results a agreement with previous work, however at high fields the curr

ases more rapidly than the field strength. The mobility of the ve ion in the liquid was found to be 8×10^{-4} cm^2 V^{-1} sec^{-1}.
K.N.R.Taylor

904 A METHOD FOR THE MEASUREMENT OF THE MOBILITY OF ELECTRIC CHARGES IN LIQUIDS.
solo.
Cimento (Italy), Vol. 21, No. 1, 76-83 (July 1, 1961).
new technique for the measurement of the mobility of ic charges in liquids has been developed. One essentially ures the time of flight between a grid and the collecting ode which is connected to the electrometer by a suitable . This method is of easy application and the experimental ts are in excellent agreement with those obtained in liquid n by other authors.

905 PRELIMINARY RESULTS ON TWO NEW FREE RADICALS IN SOLUTION.
izi, G.Siragusa and L.Zanotti.
Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 274-7 (1960).
ench.
th Colloque Ampère Paper (see Abstr. 4734 of 1961). ESR ra of phenothiazine oxidation products are presented.
C.J.Ultee

906 EXCHANGE EFFECTS AND ANISOTROPY BROADENING OF THE HYPERFINE SPIN RESONANCE SPECM OF THE BIPHENYL NEGATIVE ION IN SOLUTION.
Powles and M.H.Mosley.
. Phys. Soc. (GB), Vol. 78, Pt 3, 370-6 (Sept., 1961).
The electron spin resonance absorption spectrum of the bil negative ion was measured at 9.5 mm wavelength in solution rahydrofuran and in diethylene glycol dimethyl ether (DGDE) the temperature range -90^0 to $+70^0$C and for concentrations 1.94×10^{-3} to 4.35×10^{-3} M. The normal nine-line hyperfine rum loses its structure with falling temperature for solution in E at about -70^0C, independent of concentration. It is thought his is due to a decrease in motional narrowing of an anisotropic rfine interaction comparable in magnitude with the isotropic rfine interaction. With rising temperature the hyperfine structure again disappears. This occurs at -34^0C for a concentration $\times 10^{-3}$ M and increases with falling concentration to $+37^0$C at $\times 10^{-3}$ M. After loss of structure the line continues to narrow increasing temperature. Similar but less extensive measurements were possible for solution in tetrahydrofuran. This effect is ht to be due to exchange, i.e. perturbation of the electron spins counters between the radicals which are diffusing through the nt. An analysis is carried out using a theory proposed by Pake Luttle (Abstr. 90 of 1960) in which a quantity related to the ratio change frequency to collision frequency is derived and which ld be constant and of order unity. This quantity is indeed found of order unity over a wide range of temperature and for the solvents but that it varies significantly nevertheless. These ations have not been explained and show that a more elaborate ry even than that proposed by Kivelson (Abstr. 20663 of 1960) is ired.

5907 TRITIUM AS AN INTERNAL SOURCE OF RADIATION IN E.P.R. STUDIES OF ORGANIC MATERIALS.
oh and J.W.T.Spinks.
hem. Phys. (USA), Vol. 35, No. 2, 760-1 (Aug., 1961).
T_2O in organic liquids forms a convenient source of radiation umventing the problem of EPR background in the container. tra obtained from methanol, ethanol and acetone were identical ose obtained X- or γ-ray irradiation. The same technique can pplied to gases and imiscible liquids by rapid condensation of xture of the vapours.
C.J.Ultee

ELECTRON PARAMAGNETIC RESONANCE OF SOLUTIONS OF HIUM IN LIQUID AMMONIA. See Abstr. 16600

5908 PROTON SPIN—LATTICE RELAXATION TIMES IN VERY DILUTE AQUEOUS SOLUTIONS OF Ni^{++} AND $^+$ IONS. J.W.Hennel, K.Krynicki, T.Waluga and G.Zapalski.
phys. Polon. (Poland), Vol. 20, No. 1, 77-82 (1961).
Proton magnetic spin—lattice relaxation time T_1 in air-free eous solutions in the Ni^{++} concentration range between 2×10^{16} 2×10^{18} ions/cm^3 was measured. For Ni^{++} and Mn^{+++} ions the ndence of $1/T_1$ on concentration throughout the temperature ge 10-90^{0}C was shown to be linear. A simple method was eloped for obtaining air-free samples of aqueous solutions.

15909 THE INFLUENCE OF MOLECULAR SHAPE ON SOLVENT SHIFTS IN THE PROTON MAGNETIC RESONANCE SPECTRA OF POLAR SOLUTES.
P.Diehl and R.Freeman.
Molecular Phys. (GB), Vol. 4, No. 1, 39-47 (Jan., 1961).
The variation of the position of high resolution proton magnetic resonance lines of a polar solute with dielectric constant of the solvent may be calculated on the assumption that the dipole, polarizes the surrounding medium, setting up an electrostatic "reaction field" which alters the distribution of the electrons responsible for magnetic shielding. The theory predicts that the shape of the solute molecule should be important in determining the magnitude of this reaction field. The magnetic shielding values measured in a range of solutions of acetonitrile, representing a rod-like molecule, and of paraldehyde, a disc-like molecule, are shown to support the "shape theory" rather than the simpler treatment which assumes that all solutes are spheres. Evidence is obtained that paraldehyde is essentially only one of the many possible stereoisomers, the "chair" form with all the methyl groups in equatorial positions.

15910 MULTIPLE PROTON MAGNETIC RESONANCE RELAXATION IN A NUMBER OF MOLECULAR LIQUIDS. J.G.Powles and D.J.Neale.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 377-90 (Sept., 1961).
Experimental results are given for the proton spin—lattice relaxation times T_1 at 47.5 Mc/s for liquid ethyl benzene, bromobenzene, chlorobenzene, fluorobenzene, benzene, aniline, paraxylene, mesitylene and methyl alcohol over the whole liquid range including some supercooling. Where more than one chemical type of proton is present the distinct T_1 values were measured by the method of Abstr. 9408 of 1961. In ethyl benzene the ring proton T_1 has a minimum but the ethyl proton T_1 does not (as reported by Powles and Neale for toluene), thus emphasizing the difference in their nature. Motional correlation frequencies are deduced from the T_1 values. In ethyl benzene and aniline the substituent correlation frequency agrees with the dielectric correlation frequency. Methyl alcohol is different. The predicted ring proton correlation frequencies are lower to an extent which depends on the particular molecule and on the interpretation adopted. The results are related to shear viscosity data. $\eta T_1/T$ should not depend on temperature but does, in a way depending on the molecule and on the individual value of T_1. Thus the introduction of the viscosity in this way is not very helpful. It is concluded that in these liquids composed of non-spherical molecules the thermal molecular motions are complex, including motion about different axes at different rates. This complexity should be borne in mind when considering other motionally dependent properties of liquids.

15911 NUCLEAR MAGNETIC RESONANCE SPECTRA OF SEVERAL OLEFINIC COMPOUNDS.
D.G.de Kowalewski, V.J.Kowalewski, R.Freymann and M.Martin.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 534-6 (1960).
In French.
9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Brief report which summarizes experimental results on spectra, coupling constants, and chemical shifts obtained by the authors for a number of liquid olefinic compounds of type AB, ABX_2, and ABX_3.
P.M.Parker

N^{14} AND N^{15} NUCLEAR RESONANCE IN LIQUID NITROGEN. See Abstr. 13622

MECHANICS OF GASES

15912 CONSTRUCTION OF ACCURATE DISCONTINUOUS SOLUTIONS OF THE ONE-DIMENSIONAL GAS-DYNAMIC EQUATIONS AND THEIR APPLICATION.
V.P.Korobeinikov and E.V.Ryazanov.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 2. 265-8 (1958).
In Russian.
Accurate solutions are given of the equations governing the one-dimensional unsteady motion of a perfect gas. Special cases, including shock wave propagation, are considered.
R.F.S.Hearmon

15913 CALCULATIONS OF THE COEFFICIENT OF VISCOSITY AND THE COEFFICIENTS OF DIFFUSION FOR DISSOCIATING HYDROGEN. D.G.Clifton.
J. chem. Phys. (USA), Vol. 35, No. 4, 1417-20 (Oct., 1961).

The kinetic theory of dilute monatomic gases and mixtures was used to calculate some transport properties of dissociated hydrogen. The H_2-H_2 and $H-H_2$ interactions were assumed to obey the modified Buckingham (exp-6) potential and the Lennard-Jones (12-6) potential, respectively, and the two H—H interaction potentials ($^1\Sigma_g$ and $^3\Sigma_u$) were treated by the method of Hirschfelder and Eliason to obtain a weighted average rigid-sphere collision diameter. The coefficient of diffusion in a binary mixture of the $H-H_2$ system, and the coefficients of self-diffusion for H atoms and H_2 molecules were computed for temperatures from 1500° to 5000°K and pressures of 0.1, 0.5, 1,2, 10, 50 and 100 atm.

15914 VISCOSITY OF DUSTY GASES. W.T.Sproull.
Nature (GB), Vol. 190, 976-8 (June 10, 1961).

The author recalls experiments in which the addition of dust to turbulent gas flow through a pipe causes an immediate decrease in the pressure drop required to maintain a given flow, and describes similar work carried out more recently. A theoretical explanation of the results is attempted, [but the arguments do not seem to be satisfactory]. N.Curle

15915 INTERPRETATION OF LINEAR APPROXIMATIONS FOR THE VISCOSITY OF GAS MIXTURES. C.F.Hansen.
Phys. of Fluids (USA), Vol. 4, No. 7, 926-7 (July, 1961).

The author remarks on an apparent discrepancy between the linear terms in the coefficient of viscosity of a gas mixture and the linear form which has been derived in terms of the molecular mean free paths. He then goes on to suggest that the discrepancy may be removed by replacing the mean path between collisions by the mean path for momentum transfer. N.Curle

15916 UNSYMMETRICAL FLOW PATTERNS PAST A FINITE WEDGE PROFILE IN A HIGH SUBSONIC STREAM. J.B.Helliwell.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 401-14 (April, 1961).

The flow pattern past a thin wedge-like profile set at a small angle of attack in a gas flowing with high subsonic or sonic velocity is discussed within the order of the transonic approximation. In the model considered the flow has a stagnation point at the nose of the wedge and breaks away, with velocity equal to that of sound, from the shoulders. The velocity is subsonic throughout the whole field of flow. The solution of the boundary-value problem for the wedge in a channel is formulated as a pair of dual integral equations. The complete solution is given for the wedge in a free stream and the dimensions of the profile, together with the lift coefficient, are computed as functions of the transonic similarity parameter.

15917 APPLICATION OF THE CONSERVATION THEOREMS TO PLANE HOMOGENEOUS TRANSONIC FLOW. P.Germain.
C.R. Acad. Sci. (France), Vol. 252, No. 17, 2511-14 (April 24, 1961).
In French.

All solutions of the Tricomi equation define a law of conservation for slightly perturbed transonic flow. This result permits the writing of an expression for the general integral of the nonlinear differential equation for homogeneous flow, and defines completely the flow around a symmetrical profile at M = 1. T.C.Toye

15918 SMOKE OBSERVATION ON BOUNDARY LAYER TRANSITION CAUSED BY A SPHERICAL ROUGHNESS ELEMENT. M.Mochizuki.
J. Phys. Soc. Japan, Vol. 16, No. 5, 995-1008 (May, 1961).

Observations were made in the boundary layer along a flat plate in a wind tunnel. A sphere of various diameters was placed on the plate as an isolated roughness element and the resulting flow patterns were examined by the smoke emitted from various heights and positions relative to the sphere. The patterns were stereographically photographed from upper and lateral sides, in order to make clear the mechanism of the change of patterns with varying velocities, namely Reynolds numbers. A low velocities, peculiar vortex filaments are formed. With increasing velocity, they begin to be deformed periodically and a characteristic row of arch-shaped vortices is formed. As the velocity is further increased, the wedge-shaped turbulent region appears downstream and gradually approaches the sphere, encroaching upon the lami part. Vortex filaments parallel to the direction of the main stre appear with a constant spacing with their heads along the sides the wedge. These observations were compared with measureme by hot-wire and with the results of visualization reported by oth investigators.

15919 EXPERIMENTAL STUDY OF A BOUNDARY LAYER ALONG A ROUGH PLATE. E.A.Brun and H.Plum.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 53, 301-7 (Dec., 1960)
In French.

Measurements were made of velocity profiles in the turbule boundary layer at different stations downstream from the leadin edge, and corresponding values of the momentum thickness δ_2 a displacement thickness δ_1 were calculated. The momentum inte equation was used to calculate the skin-friction coefficient c_f, a hence the friction velocity u_f. The various profiles of velocity u were then replotted as $(u-u_\infty)/u_f$ against $y\sqrt{c_f/2}/\delta_1$, and a univer curve obtained which agrees with Clauser's results for a smooth plate except very close to the plate. N.C

15920 COVOLUME EFFECTS IN ONE-DIMENSIONAL GAS FLOW. J.N.Beri.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 233-49 (May 26, 196

By taking covolume into account, Abel's equation of state is to derive differential equation for continuous gas flow, taking int account area-change, wall friction, drag, phase-change, change molecular weight, gas injection and mixing. Analytical results f simple heat transfer are deduced and in the case of combined friction and heat transfer the numerical results are compared wi those of perfect-gas laws.

15921 MEASUREMENT OF THE TRANSPORT VELOCITY A GAS BY AN ION-TRACING METHOD. P.E.Suetin, G.T.Shchegolev and R.A.D'yachenko.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 111-14 (Nov.-Dec.
In Russian.

An ion counter is described with which a pulsed ionic cloud measured after its injection into a gas stream. Thus, the veloc of the gas stream was determined from the distance between io source and collector, and the time interval between injection an collection of the ions. The latter was taken from the middle of exposure time to α-irradiation until the ion current attained its highest value. The ion cloud acted as a tracer. It followed with great accuracy the flow of the gas without producing any disturb The accuracy of the velocity measurement was assessed as 2%. [English translation in: Instrum. exper. Tech. (USA), No. 6, 96 (Nov.-Dec., 1959; publ. Sept., 1960)]. R.Schnurr

15922 EFFECTS OF INHOMOGENEITY AND OF SHEAR F IN WEAK TURBULENT FIELDS. R.G.Deissler.
Phys. of Fluids (USA), Vol. 4, No. 10, 1187-98 (Oct., 1961).

Spectra for weak turbulence are found for: (1) turbulence i homogeneous in the direction of a uniform mean velocity; (2) an initially homogeneous turbulence becoming inhomogeneous in a verse direction because of the presence of boundaries; and (3) t bulence homogeneous with a uniform mean transverse velocity gradient. The treatment is based on two-point correlation and s tral equations. The effect of inhomogeneity is to cause a diffusi of turbulence in the direction of decreasing turbulent intensity. Longitudinal inhomogeneity produces an accumulation of energy mainly in the high wave-number portions of the energy spectrum whereas the transverse inhomogeneity causes a depletion of ene at a point in the fluid and does not alter the shape of the spectru For homogeneous turbulence with a uniform transverse velocity gradient, energy is transferred from the mean flow into the turb ence by a turbulent production term in the spectral equation. A velocity gradients the production spectrum shifts towards the lo wave-number region and the dissipation spectrum towards the h wave-number region. The pressure-force term, which is depen on the velocity gradient, transfers energy between the direction components in such a way as to oppose local isotropy in the high wave-number region. Although triple correlations are neglecte (low-turbulence Reynolds number), a term containing the mean ity gradient occurs in the spectral equation which is interpreted transferring energy between wave numbers.

15923 WIDTH OF THE TURBULENT TRAIL BEHIND A HYPERVELOCITY SPHERE. R.E.Slattery and W.
Phys. of Fluids (USA), Vol. 4, No. 10, 1199-1201 (Oct., 1961).

The growth of the gross turbulent trails behind hypervelocit

es (velocity = 9000 ft/sec) was measured at 40, 100, and 760 mm air pressure for about 10^4 diameters behind the sphere. The ure range corresponds to a factor of 19 change in Reynolds er. Little difference is noted in the growth as a function of ure, although the lower pressure trail does tend to grow ly more slowly than at one atmosphere. The atmospheric trail s as a $\frac{1}{2}$-power function of length while the lower pressure data / a $\frac{1}{2}$-power for about the first 50 sphere diameters of trail and ower thereafter.

5924 TURBULENT BOUNDARY LAYER ON A FLAT PLATE IN A STREAM OF DISSOCIATING GAS.
osterin and Yu.A.Koshmarov.
nat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 46-9 (June,).
Gives a theoretical solution of a turbulent boundary layer lem of dissociating gas on a flat plate. A half-empirical ıdtl—Kármán turbulent theory is used to solve this problem.

SOUND RADIATION FROM ELASTIC SHELLS EXCITED BY BULENT AERODYNAMIC FLOW. See Abstr. 16011

5925 MOTION OF A VISCOUS COMPRESSIBLE GAS ADJACENT TO A SLIDING PLATE.
Harlow and B.D.Meixner.
. of Fluids (USA), Vol. 4, No. 10, 1202-6 (Oct., 1961).
Numerical calculations were made of the motion of a viscous pressible gas adjacent to a flat plate moving rapidly in its own e. The analytical solutions given by Stewartson [Proc. bridge Phil. Soc. (GB), Vol. 51-202 (Jan., 1955)] were checked good agreement obtained after a slight modification was made in esults of his solution-matching technique. The computer re- illustrate the detailed flow profiles which should be useful in eneration of improved analytical solutions. In addition, com- tions were performed to show the effects of variations of ıdtl number, viscosity ratio, and plate acceleration history.

5926 THE CAUCHY PROBLEM AND THE PROBLEM OF THE PISTON FOR ONE-DIMENSIONAL UNSTEADY ION OF A GAS (SELF-SIMILAR MOTION). S.S.Grigoryan.
lad. Mat. i Mekh. (USSR), Vol. 22, No. 2, 179-87 (1958).
ussian.
A theoretical paper discussing the initial self-similar problem he one-dimensional unsteady motion of an ideal, non-heat- ducting, perfect gas (the Cauchy problem) and the problem of the -similar motion of a gas with the same properties being metrically expanded by a piston. Applications to various types xplosive impulse are considered. R.F.S.Hearmon

5927 QUASI-STATIONARY FLOW OF GAS FROM A CYLINDRICAL VESSEL OF VARIABLE VOLUME.
Belen'kii.
klad. Mat. i Mekh. (USSR), Vol. 22, No. 2, 279-85 (1958).
ussian.
A theoretical analysis is made of the flow of gas from a ndrical vessel with a piston at one end and a small hole at the r; gas is supplied to the cylinder simultaneously with the outflow ugh the hole. The differential equation governing the flow is up by establishing the energy balance of the system, and is ed for the flow gas from a vessel of constant volume, for steady of gas from the cylinder, and for the flow of gas from the sel when the piston is moving. R.F.S.Hearmon

5928 INVESTIGATION OF THE THERMAL RELAXATION IN THE FLOW THROUGH NOZZLES BY AN ANALYSIS OF GAS-KINETIC VELOCITY DISTRIBUTION.
agena and W.Henkes.
laturforsch. (Germany), Vol. 15a, No. 10, 851-8 (Oct., 1960).
erman.
The enthalpy of a gas supplies its kinetic energy during an batic expansion through a nozzle. The contribution of the molar of vibration to the beam velocity was examined by a mole- r-beam method. This contribution is appreciable for UF_6 and slight for CO_2. A Laval nozzle offers no advantage over a ple converging nozzle with regard to beam intensity.
R.Schnurmann

15929 SEPARATION EFFECT IN THE GAS CYCLONE.
J.Strnad, V.Dimic and I.Kuščer.
Z. Naturforsch. (Germany), Vol. 16a, No. 4, 442-3 (April, 1961).
In German.
A Laval nozzle with a body on which a helical groove had been cut was used to measure the enrichment of CO_2 in H_2 during laminar flow through a tube. An enrichment factor of 1.28 (corresponding to a separation factor of 1.4) was found, whereas the calculated separation factor is of the order of 10. The difference is ascribed to convection. R.Schnurmann

IONIZED-GAS FLOW IN FLAMES. See Abstr. 16157

ORIENTATION OF RIGID PARTICLES BY BIREFRINGENCE DURING FLOW. See Abstr. 15875

VAPORIZATION PROCESSES IN THE HYPERSONIC LAMINAR BOUNDARY LAYER. See Abstr. 16173

15930 THE CALCULATION OF THE VELOCITY DISTRIBUTION IN THE FIELD OF A TWO-DIMENSIONAL SYMMETRICAL AEROFOIL WITH ARBITRARY CIRCULATION.
S.N.Chaudhuri.
Proc. Nat. Inst. Sci. India A, Vol. 27, No. 2, 115-28 (March 26, 1961).
A method is developed for the calculation of the velocity distribution in the field of a symmetrical aerofoil at any incidence, with an arbitrary circulation in incompressible potential flow. Special attention is given to the trailing edge region for its importance in the prediction of the lift of aerofoils taking account of the boundary layer. The method is particularly suitable for practical applications. The only data necessary for the calculation are the section ordinates, leading edge radius of curvature and the trailing edge slope. The method described here makes use of the continuous distribution of singularities which has been so successfully used for the calculation of the velocities on the aerofoil by several authors (Neumark, 1947; Weber, 1953). The calculations of the velocities near the trailing edge and the wake show good agreement with the results obtained by the conformal transformation method.

15931 MULTI-STAGE AMPLIFIER FOR A HOT-WIRE ANEMOMETER.
J.Tacussel, J.Mathieu and M.Ailloud.
C.R. Acad. Sci. (France), Vol. 252, No. 23, 3532-4 (June 5, 1961).
In French.
A push-pull amplifier in which the response is controlled by RC filters. No component values are given. T.S.E.Thomas

Shock Waves

15932 MICROWAVE STUDY OF NON-IONIZING SHOCK WAVES. S.Takeda and M.Roux.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1395-1402 (July, 1961).
The interaction of microwave with gaseous plasmas was used to study weak shock waves in low pressure gases. The medium is weakly preionized in order to study shock waves of low Mach number, which are incapable of ionizing the gaseous medium in which they propagate. In a tube 5 mm in diameter, condenser discharges were fired for the production of shock waves up to 200 J, in a pressure range of 4—13 mm Hg in Ne and A and with Mach number up to 5, and it was found that the measured electron density increase across the discontinuity was in the ratio of the gas density ratio. The electron temperature, deduced from the measured electron—ion collision frequency, is, as expected, lower than the gas temperature estimated from the Mach number.

15933 PHYSICAL NATURE OF SHOCK PROPAGATION.
W.Band and G.E.Duvall.
Amer. J. Phys., Vol. 29, No. 11, 780-5 (Nov., 1961).
Gives an elementary discussion of the basic concepts required for an understanding of shock propagation. Simple derivations are presented of the Rankine-Hugoniot relations, Bethe's stability condition, Earnshaw's relation, and the structure of the shock front or shock profile.

15934 PROPERTIES OF THE SOLUTION OF THE PROBLEM OF POINT DETONATION IN COMPRESSIBLE MATTER. N.N.Kochina and N.S.Mel'nikova.
Dokl. Akad. Nauk. SSSR, Vol. 138, No. 2, 326-9 (May 11, 1961).
In Russian. For abstract, see Abstr. 11776 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 380-3 (Oct., 1961)].

15935 ESTIMATION OF THE CHARACTERISTIC VELOCITY FOR THE PROPAGATION OF THE DISTURBANCE UP-STREAM IN SHOCK WAVE BOUNDARY LAYER INTERACTION PROBLEMS. A.K.Roy.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 1, 1-9 (Jan. 26, 1960).
In shock boundary-layer problems, consideration of the whole of the boundary layer is not important. On similarity considerations and utilizing existing experimental data, Roy (1959) calculated the thickness of the critical viscous sub-layer (a fraction of the total boundary layer thickness) which is important for the propagation of the disturbance up-stream in such problems. In the present paper, following the method of Roy, the Mach number of the characteristic flow in the region of this viscous sub-layer is estimated and found to lie between the limits 0.15 and 0.6 (in cases of flow without or with separation).

15936 ON STREAMLINES WITH REFERENCE TO A SHOCK SURFACE. R.S.Mishra.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 569-80 (Nov. 26, 1960).
The streamlines in a fluid are not, in general, capable of being intersected by a family of orthogonal analytical surfaces. The necessary and sufficient conditions are obtained for the streamlines to possess the above property. The possibility of the existence of any point (points) on a streamline such that the shortest distance between the streamline and a consecutive streamline at that point (points) is of the second or higher order is considered. Some relations and properties of the tendency and divergence of a tangent vector to a streamline are also obtained.

15937 THEORETICAL INVESTIGATION OF STRONG SPHERICALLY SYMMETRICAL CONVERGENT COMPRESSION SHOCKS IN DEUTERIUM GAS. H.Völcker.
Atomkernenergie (Germany), Vol. 5, No. 6, 209-17 (June, 1960).
In German.
There are undesirable discrepancies between experimental experience and the theoretical treatment of shock waves in gases, assuming the laws of an ideal gas. A theoretical study by Davies (Abstr. 3180 of 1948) of flat compression shocks in air, assuming an ideal shock surface, gives temperatures (in the case of temperature-dependent specific heats) which were confirmed experimentally by Model (Abstr. 4932 of 1958). The propagation of spherically symmetrical convergent compression shocks in deuterium gas was investigated in a similar fashion. The problem leads to a system of partial differential equations of the hyperbolic type, with initial values calculated from the solution of the stationary flat problem. Approximate solutions of the series of differential equations were arrived at according to a numeral integration method, developed by Lax, with the aid of the electronic computer Z-22. The radial pressure increase in the area of the convergence centre was compared to the solution offered by Guderley. The gas was pre-heated in front of the shock surface to 3000°K, at constant pressure, to provide the temperature increase. The effect of this on the physically interesting quantities behind the shock surface was compared with the corresponding effect of pressure increase in the shock surface. By heating to a temperature of 1500°K under atmospheric pressure, with a starting pressure of 1000 atmospheres behind the shock surface, fusion temperatures may be expected immediately behind the shock surface for a sphere of 1 metre diameter and at a distance of 1 cm from the centre of convergence.

15938 COMMENTS ON "LUMINOSITY BEHIND SHOCK WAVES IN XENON". W.Roth.
Phys. of Fluids (USA), Vol. 4, No. 6, 788-90 (June, 1961).
This is a detailed criticism of part of Gloersen's work (see Abstr. 169 of 1961). Among other things, it is pointed out that Gloersen's method of plotting involves the unlikely assumption that the reaction mechanism is first order with respect to Xe density. The possibility of wall effects contributing to the luminosity is discussed. A.G.Gaydon

15939 ANSWER TO THE COMMENTS BY WALTER ROTH P.Gloersen.
Phys. of Fluids (USA), Vol. 4, No. 6, 790 (June, 1961).
In reply to Roth (preceding abstract), it is pointed out that various parameters are so nearly constant under the experime conditions that conclusions from the plots are unaffected. Wor quoted which shows that luminosity is constant across the diam of the shock front, so that wall effects cannot be important. A.G.G

15940 THE PROPAGATION OF STRONG DISCONTINUITI IN A MULTI-COMPONENT MEDIUM. Ya.Z.Klein
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 2, 197-205 (1958).
In Russian.
A theoretical paper in which, following Rakhmatulin (1956 the motion of a multi-component body is regarded as the mutu penetration of the individual components making up the body. concept is applied to establish the conditions at a strong disco ty and to the discussion of shock waves of low intensity. R.F.S.He

15941 A PLANE SOUND WAVE OF FINITE AMPLITUDE MOVING MEDIUM. A.L.Polyakova.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 6, 1347-9 (April 21, 196
In Russian.
Riemann solutions describing the propagation of plane sou waves of finite amplitude (shock waves) in a moving medium a summarized and discussed for three cases of relative motion involving medium, source, and observer. [English translation Soviet Physics—Doklady (USA, Vol. 6, No. 4, 344-5 (Oct., 1961 J.M.

15942 EXPERIMENTAL DEMONSTRATION OF MACH-REFLECTION OF DETONATION WAVES IN SOLI V.V. E.A.Feoktistova.
Dokl. Akad Nauk SSSR, Vol. 136, No. 6, 1325-7 (Feb.21, 1961).
In Russian.
In a solid body (made of "V.V.") two systems of elastic, p progressive waves move against each other at an oblique angl They generate another system of plane waves which progresse direction of the line bisecting the angle between the wave vect of the two primary systems. The presence of the third wave recorded photographically and the wave velocity is dervied. Measurements agree reasonably well with theoretical calculat [English translation in: Soviet Physics—Doklady (USA), Vol. 6 No. 2, 162-6 (Aug., 1961)]. R.Eise

15943 TEMPERATURE MEASUREMENTS OF SHOCK W AND DETONATIONS BY SPECTRUM-LINE REVE III. OBSERVATIONS WITH CHROMIUM LINES.
A.G.Gaydon and I.R.Hurle.
Proc. Roy. Soc. A (GB), Vol. 262, 38-50 (June 13, 1961).
For Pt II see Abstr. 14732 of 1960. Temperature measur were made with the chromium resonance triplet at 4254, 4274 4289 A, controlled amounts of chromium being introduced in t of the volatile carbonyl; this method has the advantage that it used with explosive mixtures. Measurements of vibrational r tion time were made for carbon monoxide between 2200 and 2 and of the rate of dissociation of hydrogen in hydrogen + argo tures between 2400 and 2800 °K. Temperature irregularities fronts of shocks through argon or neon are discussed, but no factory explanation for them has been found. Excitation proce in monatomic gases are also examined. The method was used study the temperature distribution behind detonations initiated shocks of various strengths. For ethylene + oxygen detonatio chromium excitation temperature is very high at the front; thi attributed to chemiluminescent excitation in the reaction zone carbon monoxide + oxygen detonations initiated by weak shock interesting steps were observed in the temperature behind the and these are explained as being due to delayed ignition behin shock and an acceleration of the front leading to detonation af front has travelled some way along the shock tube.

THE IGNITION POINT OF A COMBUSTIBLE MIXTURE I SHOCK WAVES. See Abstr. 16155

944 OBSERVATION OF FAR-INFRARED RADIATION FROM SHOCK WAVES.
f Kimmitt, A.C.Prior and P.G.Smith.
Ia ·e (GB), Vol. 190, 599-601 (May 13, 1961).
Describes infrared radiation in the wavelength range 0.1 to
·. ım, which was observed in the emission from a plasma
·e rated by a shock wave in argon, and suggests that this pheno-
n ɔn has value for diagnosing shock-wave plasmas. In particular
t suggested that plasmas with electron densities greater than
. .0^{14} cm^{-3}, beyond the range of standard microwave methods,
:t ld be detectable with a detector now being developed on these
1. . N.Curle

GASEOUS STATE

5945 INELASTIC SCATTERING OF SLOW NEUTRONS FROM METHANE.
F .Randolph, R.M.Brugger, K.A.Strong and R.E.Schmunk.
P s. Rev. (USA), Vol. 124, No. 2, 460-9 (Oct. 15, 1961).
Partial differential cross-sections for the scattering of
n rons of 0.0150, 0.0252, 0.0706, 0.103, and 0.142 eV initial
e ·gy into angles of 16.3°, 26.0°, 36.4°, 47.6°, 59.5°, 72.1°, and
8 ° from samples of room-temperature methane gas are pre-
s ed. These are converted to scattering law and are compared
h ·ree calculations: (1) the ideal gas calculation gives limited
a ·ement using a mass of 3.2, the average of the Sachs—Teller
c s tensor; (2) the Krieger—Nelkin approximation (Abstr. 5658 of
1 1) which includes effects of zero-point vibrations is a better fit,
c underestimates in the region of large momentum transfers;
[ı calculation using exact thermal orientation averages of the
n rix elements gives the best fits. None of the calculations
e lain the results at small energy and momentum changes; this
c ·greement is attributed to the classical treatment of the
r itional states in these calculations.

THE SCATTERING OF SUBTHERMAL NEUTRONS BY H_2O, O_2 AND C_6H_6. See Abstr. 13429

DENSITY OF AMMONIA VAPOUR ABOVE ATMOSPHERIC ESSURE. See Abstr. 15836

DENSITY OF METHYL MERCAPTAN VAPOUR ABOVE MOSPHERIC PRESSURE. See Abstr. 15837

5946 THERMAL DIFFUSION IN GASEOUS MIXTURES.
M.El Nadi and N.Faragi.
Chim. phys. (France), Vol. 58, No. 3, 296-9 (March, 1961).
French.
Thermal separation data within the temperature range
-480°K are reported for the gaseous mixtures N_2—N_2O and
-SO_2. Unlike the mixtures H_2—CO_2, H_2SO_2, and H_2—C_2H_5Cl,
re the diffusion is constant within the above range, the above
a afford no linear relationship between the separation and
ıo T_1/T_2, but indicate a gradual diminution in the ratios of thermal
usion and separation with decreasing temperature.
H.H.Hodgson

15947 THERMAL DIFFUSION OF BINARY GAS MIXTURES.
S.C.Saxena and S.M.Dave.
v. mod. Phys. (USA), Vol. 33, No. 2, 148-52 (April, 1961).
Describes some detailed calculations, carried out by both the
apman—Cowling and the Kihara methods, for thermal diffusion
a particular type of binary mixture. N.Curle

15948 TEMPERATURE DEPENDENCE OF THE THERMAL DIFFUSION FACTOR FOR HELIUM, NEON, AND GON. S.C.Saxena, J.G.Kelley and W.W.Watson.
/s. of Fluids (USA), Vol. 4, No. 10, 1216-25 (Oct., 1961).
The isotopic thermal diffusion factor for He, Ne, and A was
asured by an all-glass "swing separator" with its lower tube
ls at 78° and 195°K, extending the temperature range of earlier
a. These new data, along with the older ones, are interpreted
terms of the L-J (12-6) and modified exp-six potentials. Various
ıilibrium and nonequilibrium properties are calculated and com-
ed with the experimental data. An equation is developed which
ates the thermal diffusion factor with the absolute values of the
cosity, diffusion coefficient, and their derivatives and is
sentially independent of the nature of intermolecular force. The thermal diffusion values are consistent with the available experimental data of viscosity and diffusion, through the use of the proposed relation, but more accurate data on diffusion as a function of temperature are needed for a precise evaluation. Approximate calculations are given to estimate the quantum corrections for He at 78° and 195°K.

THERMAL DIFFUSION IN D_2—HT AND OTHER HYDROGEN MIXTURES. See Abstr. 13976

15949 INVESTIGATIONS ON SUSPENDED PARTICLES IN DIFFUSING GASES. K.H.Schmitt and L.Waldmann.
Z. Naturforsch (Germany), Vol. 15a, No. 10, 843-51 (Oct., 1960). In German.
The velocity of charged silicone droplets in an electric field has been measured. The field was produced between parallel plates which consisted of wire gauze, so that gas could diffuse freely through these electrodes. Droplets which are small compared with the mean free path of the gas have a velocity which is proportional to the difference of the square root of the moleculer weight of the gas, the diffusion coefficient, and the gradient of the mole fraction. Droplets which are large compared with the mean free path are subject to a Stokes force. The diffusion of nitrogen against eight gases (H_2, C_2H_2, C_2H_4, C_2H_6, O_2, A, CO_2, C_3H_8) and one gas mixture (CO_2/C_3H_8) was examined. R.Schnurmann

IONIZATION EQUILIBRIUM EQUATION OF STATE. See Abstr. 16253

15950 EXPANSION OF A COMPRESSED GAS FROM A CONTAINER. J.C.Bellet and N.Manson.
C.R. Acad. Sci. (France), Vol. 252, No. 23, 3547-9 (June 5, 1961). In French.
Data are reported for P, V, T, and Q (heat exchange) during the discharge of compressed dry air at constant rate. Details of the apparatus used are included. Q is determined from the formula,

$$Q = NE - N_0E_0 + G/M\int_0^t H\,dt,$$

where N = number of molecules in the container at time t, M = molecular weight, E = energy, G = rate of flow, and H = molecular enthalpy.

$$Q_R = \int_0^t NT\,dS = Nq_R + \int_0^t q_R\,dt$$

is also evaluated, where $q_R = T\,dS$, is the heat exchange for reversible expansion. It is found that the irreversibility, $Q-Q_R$, decreases with increase in rate of expansion. H.H.Hodgson

15951 THE SECOND VIRIAL COEFFICIENT FOR POLAR GAS MIXTURES. S.Kielich.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 433-45 (1961).
Deals with the theory of the second virial coefficient $B(T) = \Sigma\Sigma x_i x_j B^{(ij)}$ of the equation of state for polar gas mixtures. General formulae for the virial coefficients $B^{(ij)}$ are derived, containing, in addition to the contribution arising from intermolecular central forces, terms due to the various tensor forces acting between polar molecules: dipole—dipole, dipole—quadrupole, dipole—octupole and quadrupole—quadrupole interaction, as well as dipole-induced dipole and quadrupole-induced dipole inductive interactions. The formulae are given in two forms: the general form derived by tensor formalism and relating to polar molecules of arbitrary symmetry and arbitrary central-force potential, and the special case of molecules with axial symmetry and a Lennard-Jones (6—12) potential. The latter formulae are applied to one-, two- and three-component gas mixtures.

15952 TETRAFLUOROMETHANE: P—V—T AND INTERMOLECULAR POTENTIAL ENERGY RELATIONS.
D.R.Douslin, R.H.Harrison, R.T.Moore and J.P.McCullough.
J. chem. Phys. (USA), Vol. 35, No. 4, 1357-66 (Oct., 1961).
Measurements of the gas compressibility of tetrafluoromethane were made in the region, 0-350°, 15-394 atm. From these results, values of the compressibility factor $Z = PV/RT$, the second, third, and fourth virial coefficients, and the parameters of the Beattie—Bridgeman and Benedict—Webb—Rubin equations of state were derived. The virial coefficients were correlated by the Lennard-Jones (12, 6), Lennard-Jones (28, 7), Stockmayer, and Kihara intermolecular potential energy functions, and numerical values for the molecular parametres were obtained. One of the first tests

of the theoretical fourth virial coefficient of the Lennard-Jones (12, 6) potential was made using the experimental fourth virial coefficients of tetrafluoromethane.

A TEST OF THE LENNARD-JONES POTENTIAL FOR NITROGEN AND METHANE. See Abstr. 15847

15953 THEORY OF TRANSPORT AND RELAXATION PHENOMENA IN A GAS MIXTURE. I-III.
M.J.Offerhaus.
Proc. K. Ned. Akad. Wetensch. B (Netherlands), Vol. 64, No. 3, 368-80, 381-91, 392-410 (1961).

This is part of the author's thesis which involves a critical review of the existing kinetic theory of gases and original contributions. The latter are mainly concerned with the "kinetic stage" of molecular movement which follows well defined initial conditions for individual molecules and precedes the "hydrodynamical stage" in which a local density, velocity and temperature is well defined. The kinetic stage has not been given much attention in the past. In this stage Boltzmann's collision equation is valid but cannot be solved by the method of Enskog or Chapman. During the kinetic stage relaxation processes occur; the parameters characteristic for these processes are derived from the eigenvalues of the linearized collision operators. The relaxation of diffusion currents is specific to mixtures. In the present papers those features of the theory are emphasized which involve deductions different from those of the single molecule theory. The argument includes the velocity distribution, entropy production and the relaxation processes during the kinetic stage and later. R.Eisenschitz

15954 ON THE MINIMUM OF THE WORK NEEDED TO SEPARATE TWO PERFECT GASES. R.Marchal.
C. R. Acad. Sci. (France), Vol. 252, No. 20, 3018-20 (May 15, 1961). In French.

A formula is derived for the minimum work needed to separate two perfect gases; the derivation does not involve semipermeable membranes but is based upon a consideration of a centrifugal process. D.ter Haar

15955 IRREVERSIBLE PROCESSES IN GASES WITH INTERNAL DEGREES OF FREEDOM IN WEAKLY COUPLING APPROXIMATION. B.Baranowski.
Bull. Acad. Roy. Belgique A. Sci., Vol. 47, No. 2, 111-22 (1961)

The theory of weakly coupled systems due to Prigogine and his coworkers, is extended to polyatomic gases.

15956 THE TEMPERATURE FUNCTION OF MOLAR HEAT. H.Faltin.
Wiss. Z. Tech. Hochsch. Dresden (Germany), Vol. 9, No. 5, 1167-72 (1959-60). In German.

The molar heat (C_p) for each of 25 gases is set up as a power series (in some cases up to five terms) in the temperature. The coefficients are estimated directly from existing data or from a knowledge of the "characteristic temperature" for use in the expression for C_v of an oscillator. The (temperature) range of validity is given. The maximum error is 1% or less and the temperature at which it occurs tabulated. W.Good

15957 THE EFFECT OF STRONG ELECTRIC AND MAGNETIC FIELDS ON THE DEPOLARIZATION RATIOS OF GASES. A.L.Andrews and A.D.Buckingham.
Molecular Phys. (GB), Vol. 3, No. 2, 183-9 (March, 1960).

The influence of a strong electric field F on the polarization of light scattered elastically by small gaseous molecules is investigated. Two effects are found: (i) The field distorts the molecules, thereby changing their polarizabilities. If they are isotropically polarizable when F = 0, and hence capable of scattering only polarized light from a parallel beam, this distortion may lead to depolarization. For inert gas atoms, this depolarization is proportional to F^4, and hence normally very small, but for tetrahedral molecules it is proportional to β^2F^2, where β is the first hyperpolarizability of the molecule. (ii) F tends to orientate anisotropic molecules, thereby affecting the polarization of the scattered light; this effect is related to the anisotropy in the molecular polarizability, and to the dipole moment, but is not likely to lead to information that is not obtainable by simpler means. The effect of a strong magnetic field, in place of F, is also discussed.

15958 TEMPERATURE EFFECT ON THE SCATTERING COEFFICIENTS OF NONIDEAL GASES AT CONSTA PRESSURE. L.Wijnberg.
J. Opt. Soc. Amer., Vol. 51, No. 8, 916-17 (Aug., 1961).

For air in the range $\mp 40^\circ$C, the temperature coefficient of the second virial coefficient affects the scattering coefficient o light by about the same amount as the refractivity factor discu by Deirmendjian (Abstr. 9087 of 1959). G.F.L

15959 ABSORPTION IN THALLIUM BROMIDE VAPOUR. E.Ostaszewicz.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 455-61 (1961).

Absorption of light in thallium bromide vapour was invest as a function of the vapour density, temperature, and admixtur of inert gases. Measurements were carried out with a grid spectrograph of 3 m grid curvature radius. The light source v a hydrogen lamp. The duration of irradiation was 8 hours. Ab tion was found to depend on the vapour density and to be indepe of the temperature of the absorption tube at constant pressure and of admixtures of foreign inert gases, and to consist of con ous absorption in the ultraviolet range and of bands situated in long-wave region. Isotope splitting due to the presence of two bromine isotopes yielded the magnitude of $\rho = \sqrt{\mu_1/\mu_2}$; the lat was compared with the figures obtained theoretically. From t system of bands, the heat of dissociation in the normal and excited states was computed. The thallium bromide molecule was shown to be an atomic compound when in the vapour state: it dissociates optically into a thallium atom in the normal stat and an excited atom of bromine.

15960 SOME SPECTRAL EMISSIVITIES OF WATER VAP IN THE 2.7 μ REGION. R.H.Tourin.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1225-8 (Nov., 1961).

The measurements, at temperatures up to 1273°K, were us calculate spectral and integrated infrared radiance of hot wate vapour for several cases of interest. The spectrum of hot H_2O relatively poor in strong "hot" bands, in contrast to the case o The general character of the rotational structure in the spectr the hot gas is similar to the case of room temperature, althou some additional lines are observed at high temperatures. Con sequently, care must be taken in selecting the spectral interva over which radiance integrals are to be calculated.

15961 THE OBSERVATION OF POSTLUMINESCENCE OBTAINED AT LOW TEMPERATURE IN THE REACTION OF ACTIVE NITROGEN OR THE ACTIVE MIXTUR ($N_2 + H_2$) WITH SIMPLE ORGANIC SUBSTANCES.
G.Pannetier, P.Goudmand, H.Guenebaut and L.Marsigny.
J. Chim. phys. (France), Vol. 57, No. 11-12, 959-65 (Nov.-Dec 1969). In French.

Describes the spectra of the postluminescence of the depo formed at liquid-nitrogen temperatures by the mixture of activ nitrogen (or active $N_2 + H_2$) with each of the following: C_2H_2, CH_3Cl, CH_3CN, and $(CH_3)_2NH_2$. They contain bands of the CN v system, CN red system, CH and NH, in addition to a continuum between 4000 A and 6000 A. The characteristic spectrum of a nitrogen is also present. R.W.Ni

15962 FLUORESCENCE SELF-QUENCHING IN AROMAT VAPOURS; THE ROLE OF EXCITED DIMERS.
B.Stevens and P.J.McCartin.
Molecular Phys. (GB), Vol. 3, No. 5, 425-33 (Sept., 1960).

At temperatures sufficiently high to produce an appreciab pressure of 9, 10-diphenylanthracene, perylene or pyrene, the quantum yield of fluorescence is found to be independent of vapour pressure. The negative temperature coefficient of self quenching in anthracene vapour is explained in terms of the dissociation of an excited dimer which is also responsible for delayed fluorescence. The pressure-dependence of the excited dimer lifetime at low pressures is shown to be consistent with a pressure-independent quenching constant if the second-order dissociation of the excited dimer becomes first-order at highe pressures.

15963 NONRESONANT DIELECTRIC DISPERSION IN ASYMMETRIC ROTORS. J.E.Boggs and A.P.Dea
J. chem. Phys. (USA), Vol. 35, No. 4, 1178-80 (Oct., 1961).

Dielectric dispersion measurements at 400 Mc/s and 40.0 are reported for $CH_2=CHCl$ and $CH_2=CF_2$ in the gas phase.

results for these two molecules and earlier measurements
H_5Cl are compared with theoretical expectations for nonreson-
ispersion resulting from pressure-broadened transitions
een asymmetry doublet levels.

5964 THE HALL EFFECT IN THE VISCOUS FLOW OF IONIZED GAS BETWEEN PARALLEL PLATES UNDER NSVERSE MAGNETIC FIELD. H.Sato.
ys. Soc. Japan, Vol. 16, No. 7, 1427-33 (July, 1961).
The electrical conductivity of an ionized gas is anisotropic
e presence of a magnetic field (Hall effect). The conductivity
pressed by a tensor in the same form for both fully and
ally ionized gases. By the use of modified Ohm's law and
entional magnetohydrodynamical equations the incompressible
ous flow between parallel plates under the transverse magnetic
is analysed and an exact solution is obtained when the magnetic
olds number is small. The numerical results reveal a
arkable effect of anisotropy of conductivity. The acceleration
deceleration of viscous ionized gas under combined electric
magnetic fields are also calculated.

5965 NUCLEAR MAGNETIC RESONANCE MEASUREMENTS IN HYDROGEN GAS. M.Lipsicas and M.Bloom.
ad. J. Phys., Vol. 39, No. 6, 881-907 (June, 1961).
The proton spin-lattice relaxation time T_1 was measured for H_2
using pulse techniques over the temperature range 39° to 300° K
at pressures up to 150 atmospheres. T_1 is proportional to
sity, ρ, at low densities and constant temperature, over the
re temperature range studied. Deviations from linearity due to
e-body collisions are observed at densities of the order of
Amagats. T_1/ρ for the dilute gas is approximately constant
n about 100° to 300° K but increases sharply at lower tempera-
s. The spin—spin relaxation time T_2 was measured at 78° K
found to be proportional to ρ but shorter than T_1. The diffusion
stant D was measured, using the properties of the spin echo, at
K in the dilute gas. $D\rho$ was found to be constant. An analysis
he temperature dependence of T_1/ρ using the theory of Needler
Opechowski (Abstr. 9424 of 1961) shows that the excited
tional states of ortho-H_2 probably play no role in the spin—
ice relaxation below 300° K. The T_1 results are interpreted in
ns of the theory of Oppenheim and Bloom (Abstr. 5033 of 1960;
0 of 1961) to give information on the anisotropic H_2—H_2 inter-
ons. The constancy of T_1/ρ at high temperatures cannot be
erstood in terms of the classical properties of the gas. Quantum
hanical diffraction effects play an extremely important role in
spin—lattice relaxation even at high temperatures because of
very short range nature of the anisotropic interactions.

5966 MICROWAVE FARADAY EFFECT IN WEAKLY MAGNETIC GASES. M.L.Sage.
hem. Phys. (USA), Vol. 35, No. 3, 969-73 (Sept., 1961).
The microwave Faraday effect is proposed as a method of
asuring rotational magnetic moments in gases. The theory of
Faraday effect is developed by using the method of Karplus
l Schwinger. In particular it is applied near a microwave
sorption frequency of the gas. The magnitude of the effect indi-
es that the Faraday effect may be a more satisfactory method of
asuring small (less than 0.1 nuclear magneton) magnetic moments
n the Zeeman effect. However, it requires intensity rather than
quency measurements and is therefore difficult.

VACUUM PHYSICS

15967 COMPUTATIONS IN VACUUM TECHNIQUES. J.Delafosse and G.Mongodin.
le (France), Vol. 16, 109 pp. (March-April, 1961). In French.
A review of selected elementary parts of the kinetic theory of
ses is followed by the consideration of gas flow in vacuum pumping
stems under various conditions. Flow in pipe line systems is
alt with in some detail for various modes of flow and cross
ctional shapes. Nomograms and graphs are given to simplify
lculation. The effect of degassing on pump-down time is
scussed and the degassing rate of a number of materials obtained
perimentally is given. The pressure distribution in multiple
mping systems having distributed gas loads such as occur in a
oton synchrotron is considered. Finally the sizing of pumps
cluding forepumps, booster pumps and vapour pumps and their
rious combinations is discussed followed by sample calculations
some typical installations. W.Steckelmacher

15968 PULSE COMPRESSION OF GAS BY UNTIGHT PISTON. J.Groszkowski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 11-12, 667-72 (1960).
The transient pressure conditions during compression by an untight piston was investigated theoretically. Some specific examples were worked out assuming molecular flow conditions in the gap. W.Steckelmacher

15969 THE THEORETICAL DEVELOPMENT OF THE VAPOUR VACUUM PUMP. N.A.Florescu.
Vacuum (GB), Vol. 10, No. 3, 250-9 (June, 1960).
The empirical development of the vapour pump led to the rejection of such phenomena as diffusion or condensation as the only processes involved in the function of this instrument. Further theoretical attempts which ignored the action of the vapour jet in producing a high vacuum have failed to correctly interpret the experimental results. By considering the removal of the gas molecules by the vapour stream as the basic process, a satisfactory theory of the vapour pump has been obtained. The theoretical conclusions are able to describe the working mechanism of the pump, to explain a large variety of experimental results, and to indicate the proper way of achieving design improvement.

15970 ON THE GENERAL PRINCIPLES OF CHEMICAL AND IONIC PUMPING. R.N.Bloomer.
Vacuum (GB), Vol. 10. No. 3, 260-2 (June, 1960).
Some differences between physical and chemical adsorption are emphasized. The distinction between chemical and ionic pumping is defined and discussed, and examples quoted, both recent and historical. Since in getter-ion pumps different kinds of gases have to be handled simultaneously, examples are mentioned where the presence of some gases is known to greatly influence the kinetics of adsorption of other particular gases. In any case, the interpretation of the readings obtained when checking pump performance is hazardous when gases of differing condensation coefficient are present together. A simple test that measurements are well-founded is described. Some surface reactions that can limit the performance of getters, and ways of possible improvement, are suggested.

15971 PUMPING OF ARGON, NITROGEN AND HYDROGEN IN A BAYARD—ALPERT GAUGE.
B.Cobic, G.Carter and J.H.Leck.
Brit. J. appl. Phys., Vol. 12, No. 8, 384-9 (Aug., 1961).
The pumping of nitrogen and hydrogen in Bayard—Alpert gauges was investigated as a function of the electrode potentials, the gauge temperature and the gas charge upon the walls. The results are compared with earlier values obtained in argon and in which the pumping mechanism is known. It is shown that ion pumping cannot account for the high pumping speed of nitrogen and it is concluded that mechanisms such as sputtering of the tungsten filament and the formation of tungsten nitride or the production of metastable nitrogen are unlikely to explain the observations. The pumping of hydrogen is confirmed to be due to dissociation of H_2 at the cathode with subsequent physical adsorption of H atoms at the walls, and is found to be greatly in excess of any ion pumping which may occur. The presence of liquid nitrogen traps during experiments was found to exert a profound effect on the gauge pumping of nitrogen.

15972 THE INFLUENCE OF THE INITIAL CONDITIONS ON THE PRESSURE DECREASE DURING IONIC PUMPING. L.Pátý and P.Schürer.
Czech. J. Phys., Vol. 10, No. 7, 536-43 (1960). In Russian.
A description is given of an experimental investigation of the influence of the initial pressure and method of outgassing an evacuated system on the pressure decrease during pumping with an ionization gauge. Measurements were carried out in a system containing two ionization gauges and two valves using the method of cascade pumping. Conclusions as to the influence of these conditions on the pressure decrease are reached on the basis of the measurements,and the causes of this influence are discussed.

15973 ON THE GLASS WALL POTENTIAL IN THE IONIZATION PUMP. G.Comşa.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 4, 845-50 (1959). In Roumanian.
Referring to a discussion published in "Vakuum—Technik" [Vol. 8, No. 3, 76 (1959)], the author expresses his point of view as to the glass wall potential in the ionization pump. Based both on

theoretical considerations and on some experimental data, the conclusion is drawn that in the case of an adequate operation, the pump wall will settle at a potential more negative by a few volts than the filament potential. The existence of this negative voltage is essential for the proper operation of the pump. In conclusion, the author makes a few remarks in connection with Baker's and Yarwood's observations in the framework of the above-mentioned discussion [Vacuum—Technik (Germany), Vol. 6, No. 8, 186 (1957)].

15974 ATTAINMENT OF ULTRAHIGH VACUA, REDUCTION IN SURFACE DESORPTION, AND THE ADSORPTION OF HYDROGEN BY EVAPORATED MOLYBDENUM. A.L.Hunt, C.C.Damm and E.C.Popp.
J. appl. Phys. (USA), Vol. 32, No. 10, 1937-41 (Oct., 1961).

Deposition of molybdenum by vaporization from simple hairpin filaments was found to reduce pressures in both unbaked and moderately baked stainless steel vacuum systems to 4×10^{-10} mm Hg. A deposit of 300 mg from a single filament, 0.050 in. in diameter and 6 in long, maintained an unbaked 85 litre volume at pressures below 10^{-9} mm Hg for over 40 hr with the aid of a small well-trapped diffusion pump. For a substrate area of 8×10^3 cm^2, the initial pumping speed of a molybdenum deposit was found to be as high as 10^5 litres/sec for hydrogen and 8×10^4 litres/sec for deuterium. The sticking probability for either hydrogen or deuterium on this deposit is estimated at 0.3. A similar system, baked at 200° C for several days while pumped by an oil-free ion pump, attained 2×10^{-10} mm Hg with molybdenum evaporation. When the ion pump was valved off, the pressure in this 75 litre system remained at 2×10^{-10} mm Hg for two weeks with no external pumping.

15975 DEVICE DESIGNED TO MAINTAIN A CONSTANT GAS PRESSURE IN KINETIC SYSTEMS. E.R.S.Winter.
J. sci. Instrum. (GB), Vol. 38, No. 9, 345-8 (Sept., 1961).

A vacuum-tight stainless steel piston pump containing mercury is described which can be attached to a glass high-vacuum line. The movement of the piston is controlled to raise or lower the level of mercury in a glass burette so as to keep the pressure in the system constant. The movement of the piston is recorded upon a chart driven by a synchronous motor to give a record of the volume change with time in the gas phase at constant pressure; three chart speeds are provided. Pressure control is by matched Pirani gauges in a Wheatstone bridge network at low pressures, or by a mercury manometer with sealed-in metal contacts at higher pressures; associated circuits are described.

15976 THE THERMAL VACUUM GAUGE IN PULSE PRESSURE OPERATION. J.Groszkowski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 1, 45-51 (1961).

The transient response of a Pirani type hotwire thermal conductivity gauge operating in a bridge circuit was examined theoretically. The case of a sudden increase in pressure followed by an exponential decay was worked out. The effect of various parameters on the response time was examined. W.Steckelmacher

15977 PHOTOMULTIPLIER IONIZATION GAUGE. H.Riemersma, R.E.Fox and W.J.Lange.
Rev. sci. Instrum. (USA), Vol. 32, No. 2, 218-19 (Feb., 1961).

A cold-cathode ionization gauge is described, which uses a photomultiplier, illuminated by a mercury-vapour lamp, as the source of electrons. When the accelerating potentials are correctly adjusted, spurious currents cancel out and the gauge is linear from 10^{-5} to 10^{-10} torr. L.M.Roberts

15978 A PRECISION MCLEOD GAGE FOR VOLUMETRIC GAS MEASUREMENT. H.H.Podgurski and F.N.Davis.
Vacuum (GB), Vol. 10, No. 5, 377-81 (Nov., 1960).

The modified McLeod Gauge described is designed to measure pressures between 10^{-3} and 10^{-4} torr with an accuracy of ±2 %. A large-bore side arm isolated from the gauge by a cut-off replaces the usual open-end capillary. This feature provides the means for calibrating the variations in capillary depression of mercury at every position along the length of the remaining capillary without contributing to the volume of the gauge. A tapered plug used to seal the capillary end eliminates sticking even at 10^{-7} torr and also extends the range of stable calibration in the ground capillary bore up to the end seal, thus extending the usefulness of the gauge to a lower pressure limit. With these innovations, a gauge of 200 ml capacity with a capillary of one-half mm bore was found adequate for the accuracy sought. Solution of helium in the pyrex capillary accounts for errors estimated between 1 and 3 %; hence for volumetric calibration neon is preferable to helium.

15979 HEAT TRANSFER IN A MOLECULAR MANOMETER. L.Páty.
Czech. J. Phys., Vol. 10, No. 8, 603-11 (1960).

A survey is given of the processes taking place in a molecu manometer. The importance of the transfer of heat from the pl to the movable vane, which increases the temperature of the va is shown; this heat transfer changes the magnitude of the therm molecular pressure by means of which the gas pressure in the manometer is measured. A description is given of the experi-mental arrangement used to measure the vane temperature unde different conditions; a description is also given of measuremen of the temperature increase of the vane for different temperatu of the plate, different pressures and different values of the dista between the vane and the plate. An analysis of the results show how the temperature increase of the vane distorts the data of th manometer and stress is laid on the need to take heat transfer into consideration when carrying out exact pressure measureme with a molecular manometer.

15980 IONIZATION GAUGE POWER SUPPLY FOR USE IN PULSED MAGNETIC FIELD. G.A.Doran.
J. sci. Instrum. (GB), Vol. 38, No. 9, 355-6 (Sept., 1961).

An audio-frequency power supply for the filament of an ionization gauge is described. The frequency chosen is higher the natural frequency of oscillation of the filament, hence the ga may be used in a magnetic field. Stabilization is achieved by comparing the potential at one end of a high-stability resistance through which the emission current is flowing with a reference potential, and controlling the filament current from the differen of the two. Stability over several weeks of continuous working over a pressure range of 10^{-3} to 10^{-6} mm Hg is better than 1%.

DESCRIPTION OF A SUPPLY FOR AN IONIZATION GAUG WITH LOGARITHMIC SENSITIVITY. See Abstr. 16216

15981 A METHOD OF LEAK TESTING HERMETICALLY SEALED COMPONENTS UTILIZING RADIOACTIVE GAS. B.Cassen and D.Burnham.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 9, No. 1-4, 5 (Dec., 1960).

A method of leak testing hermetically sealed components su as transistors, relays, frequency standard crystals, small muni etc., utilizing a chemically inert radioactive gas (krypton-85) is described. A leak rate formula based on Poiseuille's law is developed and the limitations in measurement imposed by the r of validity of this formula and of the random nature of radioacti decay is discussed. Means for differentiating between radioacti gas which has leaked inside the part being tested and gas absorb on its surface is presented. A logarithmic rate unit called the index is proposed. A brief description of industrial equipment accomplishing leak rate measurements along with precautions t assure full safety in its operation is given.

15982 LEAK TESTING DURING THE MANUFACTURE OF SEALED-OFF VACUUM DEVICES. R.O.Jenkins.
Proc. Instn Elect. Engrs (GB), Paper 3676 M [Conference on No Destructive Testing in Electrical Engineering], publ. Nov., 1961 8 pp. To be republished in Vol. 109A(1962).

A number of methods are at present in use and others have assessed in the course of experimental work. Their advantages limitations and sensitivities as found in practice are discussed. The methods fall into two classes. The non-specific methods in volve measuring differences in total gas pressure with time or different points in a vacuum system. The specific methods dete a particular gas and are generally found to be better suited for requirements discussed; they include the halogen detector, the hydrogen diffusion detector and various types of mass spectrom While more than one method can be used for large leaks, the ma spectrometer has been found the most useful for smaller leaks, helium as the test gas. The relative merits of the conventional magnetic type, the omegatron and the linear r.f. spectrometer a discussed. The magnetic type is the most generally suitable, a various design features and precautions in use are outlined.

983 GAS DESORPTION AT RUBBING SURFACES IN HIGH VACUA. J.Groszkowski.
Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 9, No. 2, 12 (1961).
A 7 mm diameter 30 mm closed tube containing a piece of iron rolled around the inside of a Bayard–Alpert pattern ionization e. The latter was sealed-off at approximately 1×10^{-7} torr due to the rubbing action, a pressure increase to approximately 10^{-5} torr was observed. Sorption–desorption of this gas was d to be approximately reversible. F.A.Baker

984 ELECTRICAL GAS CLEAN-UP BY EXCITATION OF METASTABLE CONDITIONS. R.Jaeckel and E.Teloy.
Naturforsch. (Germany), Vol. 15a, No. 11, 1009-10 (Nov., 1960). erman.
An "electron-collision tube" operating at very low voltages was d in which electrons were emitted from a thermionic cathode accelerated towards an anode to traverse a relatively long ost field-free region in which they could cause many collisions gas molecules for excitation or ionization. Pressures of mostly e N_2 gas of up to 10^{-4} torr were established in a constant-volume s system and pressure changes were observed with an ioniza- gauge while the anode voltage was switched on and off period- ly every few minutes. Clean-up effects are reported for N_2 up 0 V. Some clean-up was observable at voltages as low as 8 V a sharp rise above 11 V attributed to excitation of molecular ogen to metastable conditions. W.Steckelmacher

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

5985 THE ELASTIC COUPLING BETWEEN LONGITUDINAL AND TRANSVERSAL VIBRATIONS OF ISOTROPIC RODS OF SQUARE AND RECTANGULAR CROSS-SECTION.
Brdička, Z.Dvořáček and M.Nováková-Dvorská.
Czech. J. Phys., Vol. 10, No. 5, 366-82 (1960).
A new approximate method for theoretically calculating long- inal vibration frequencies of isotropic homogeneous rods of are and rectangular cross-section is given. A three-dimensional gitudinal vibration is divided into three one-dimensional ones; the pling between the principal strains in question is assumed to be ar, similarly as in the static case of simple tension. The coup- between the deformations is realized by variable coupling para- ers φ or ψ depending on the order of vibrations (contrary to leigh's correction where Poisson's ratio σ is the coupling para- er). These parameters are defined by the condition that the responding frequency must be minimized (stationary). Up till Giebe and Blechschmidt (1933) have given the best approximate hod of calculation. The series of their calculated frequencies responds to the measured ones nearly as well as the frequencies culated by the present authors. The theory described here, how- r, contains a richer spectrum of frequencies and at the same e explains the frequencies measured in the range of the so-called d zone, which is the weak point of Giebe's and Blechschmidt's ory.

15986 THE ELASTIC COUPLING BETWEEN LONGITUDINAL AND TRANSVERSAL VIBRATIONS OF ISOTROPIC RODS. II. RODS OF CIRCULAR CROSS-SECTION.
Brdička, Z.Dvořáček and M.Nováková-Dvorská.
Czech. J. Phys., Vol. 10, No. 5, 383-96 (1960).
The new approximative method for calculating the frequencies longitudinal vibrations of isotropic homogeneous rods described Pt. I is used for rods of circular cross-section. Similarly to the ds of rectangular cross-section there does not exist any "dead ne" of frequencies.

15987 MEASUREMENT OF ENERGY DISTRIBUTION OF EXTENSIONAL AND FLEXURAL WAVES IN PLATES STATISTICAL EXCITATION. F.Keller.
Akustica (Internat.), Vol. 10, No. 5-6, 349-56 (1960). In German.
In plates with small thickness compared to the wave-length, and systems composed of such plates, structure-borne sound energy found in two wave types: extensional waves and flexural waves. th a high-directivity pick-up the occurence and mutual interaction these wave types was examined as a function of frequency. For simple plates a relation was found for transverse excitation which is in contrast to what is expected from flexural wave theory. At frequencies below the first two extensional wave resonances flexural wave energy exceeds extensional wave energy by 10 to 30 dB, depending on the material. At higher frequencies this relation is however changing and the extensional wave energy eventually dominates by about 10 dB. In the case of longitudinal excitation the energy ratio depends very much on the properties of the material. The effects in complicated systems consisting of several plates with different cross-sections and dimensions might be explained as a superposition of the effects observed in simple plates.

15988 STABILITY OF ORTHOTROPIC PLATES WITH A STEPWISE CHANGING RIGIDITY. M.R.Fel'dman.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 5, 1086-9 (April 11, 1961). In Russian.
Considers vibrations of a square plastic plate whose thickness changes stepwise along its width. The plate is subjected to parallel compressible stresses applied at the mean planes of each step of the plate. The strain relation is expressed by a finite difference equation and associated with an appropriate relaxation pattern. The frequency of vibration and the critical stress are obtained. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 4, 353-8 (Oct., 1961)]. J.K.Skwirzynski

15989 DYNAMICS OF ELASTOPLASTIC SHELLS AND PLATES. É.I.Grigolyuk.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1317-20 (June 11, 1961). In Russian.
The shells are assumed to be isotropic and homogeneous; their stress, stress velocity and strain velocity tensors are linearly related. The differential equations for small amplitude transverse vibrations are derived for two special cases: (1) elastoplastic shells with a low curvature; (2) cylindrical elastoplastic shells with a gaseous stream flowing past their external surface. [English translation in: Soviet Physics - Doklady (USA)]. J.K.Skwirzynski

15990 VIBRATION OF A PLATE AND SOUND RADIATION GENERATED BY AN IMPULSIVE FORCE.
Y.Tokita.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1008-19 (May, 1961).
Measurements were made on the vibrational acceleration of a point on a plate and the sound pressure near the plate surface. Attention was given to the initial values of the above quantities, together with coincidence frequency and the waveform of impulsive force, and the following results were obtained. (1) There is a close relation between the hammer momentum (mv) and the initial value (A_0) of the acceleration or the sound pressure, as expressed by the empirical formula;

$$A_0 = K_2(mv)^{K_1}.$$

The physical meaning of these coefficients is considered. (2) The correspondence between vibrational acceleration and sound pressure is fairly complex and depends upon the mechanical properties and thickness of the plate. The coincidence effect was observed. (3) The waveform of the impulsive force was observed with different stiffnesses and with various velocities of the hammer. The frequency spectrum of the vibration depends on this waveform.

15991 VIBRATION AND SOUND RADIATION OF DAMPED AND UNDAMPED FLAT PLATES. D.C.Greene.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1315-20 (Oct., 1961).
Because of the many resonances, plates have an extremely small driving-point impedance, and accurate measurements are difficult to perform. Some of the fundamental difficulties that accompany such measurements are illustrated by experimental results. Measurements performed with thin, rectangular plates show that the asymptotic laws of vibration and sound radiation predict, within the range of experimental error, the characteristic impedance and the sound radiation of plates. The theoretical prediction that damping would have no appreciable effect on either the characteristic impedance or the background level of the radiated sound pressure was found to be accurate.

15992 HIGH FREQUENCY VIBRATIONS OF CRYSTAL PLATES. R.D.Mindlin.
Quart. appl. Math. (USA), Vol. 19, No. 1, 51-61 (April, 1961).
Cauchy's two-dimensional equations of coupled flexural and extensional motion of crystal plates are extended to the next higher

order of approximation so as to accommodate the frequencies of the two lowest thickness-shear modes. In addition to the derivation of the approximate equations, theorems of uniqueness and orthogonality are established and some general conclusions are drawn regarding solutions in rectangular coordinates and vibrations of rectangular plates. B.Brown

15993 VIBRATIONS OF THICK AND THIN CYLINDRICAL SHELLS SURROUNDED BY WATER. J.E.Greenspon.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1321-8 (Oct., 1961).

Treats the free and forced vibrations of infinitely long, thick and thin cylindrical shells surrounded by water. Exact elasticity theory is used to treat unpressurized shells and an approximate shell theory is employed to treat the effects of static pressure, internal fluid, and structural damping. Comparisons are made between the results of the exact and approximate theories.

15994 SIMPLE AXISYMMETRIC THICKNESS VIBRATIONS OF A SOFT ELASTIC CYLINDER WITH A HARD, THIN, ELASTIC SKIN. Hu-Nan Chu.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1293-5 (Oct., 1961).

Frequency equations of simple axisymmetric axial shear and simple axisymmetric radial vibrations were obtained for a soft elastic cylinder with a hard, thin, elastic skin. The soft core is treated on the basis of the three-dimensional exact equations of elasticity while the thin skin is regarded as a membrane. Numerical frequencies for the first several modes for various values of the skin thickness are tabulated and their implications discussed.

15995 ON THE VIBRATION STATISTICS OF A RANDOMLY EXCITED HARD SPRUNG OSCILLATOR. II.
R.H.Lyon.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1395-1403 (Oct., 1961).

For Pt I, see Abstr. 10711 of 1960. Previous calculations of the statistical behaviour of a hard-spring oscillator excited by purely random and Gaussian noise are extended. The moments of the displacement and its extrema are found in an analytic form and their interrelations are exploited. Recurrence relations, asymptotic expressions, and computations of the moments are presented. Envelope autocorrelations for three narrow-band linear filters are found, and the mean size of clumps exceeding predetermined levels is obtained. For the hard-spring oscillator it is found that the relative envelope fluctuation is less than that of a linear oscillator and that the mean clump size is also smaller in general.

15996 RESPONSE OF HARD-SPRING OSCILLATOR TO NARROW-BAND EXCITATION.
R.H.Lyon, M.Heckl and C.B.Hazelgrove.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1404-11 (Oct., 1961).

The response of an oscillator with a non-linear stiffness of the hard-spring type to narrow band Gaussian random noise is analysed theoretically by using the method of quasi-linearization. The particular point of interest is the possibility of an occurrence of multiple-valued response or "jumps" such as one observes when the exciting force is sinusoidal. It is argued that while it does not seem possible to have multivalued response with wide-band (white noise) excitation, the response to narrow-band excitation might exhibit such behaviour owing to the temporal correlation of the source with the response. Numerical computations of the response curves do suggest multivalued response. In experiments with a non-linear oscillator, multivalued response was observed, but agreement between theory and experiment may only be claimed to be qualitative.

15997 INITIAL VIBRATIONS OF A SUPPORTED BEAM. R.V.Sharman and D.White.
Nature (GB), Vol. 191, 692-3 (Aug. 12, 1961).

The vibrations were initiated by striking strips normally to the greatest area with pendulum type hammers and the vibrations were examined by using a variable-reluctance transducer coupled through an amplifier to an oscilloscope. Photographs of oscilloscope traces are shown and a mathematical theory of the displacement of the centre of the beam at any time is presented. B.Brown

15998 RESPONSE OF NONLINEAR SHOCK MOUNTINGS TO TRANSIENT FOUNDATION DISPLACEMENTS.
J.C.Snowdon.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1295-1304 (Oct., 1961).

The transient behaviour of shock mountings disturbed by step-like displacements that invoke large departures of mount stiffness from linearity is described theoretically and compared with the behaviour of an ideally linear mounting. The influence of mount damping upon the transient motion of the mounted item is discu in detail. For the majority of step rise times considered, a mo that softens upon compression and is not heavily damped is sho to reduce both the acceleration and displacement experienced b mounted item below the values observed for a linear mounting as is normally the case in practice, a mount that stiffens upon compression. The reduction in acceleration can be comparable 10 dB for quite a wide range of step rise times. It is frequently magnitude of the acceleration to which the likelihood of damage the contents of the mounted item may be related.

15999 TRANSMISSION OF FLEXURAL WAVES THROUGH ARBITRARY INTERMEDIATE ROD.
V.P.Maslov and B.D.Tartakovskii.
Akust. Zh. (USSR), Vol. 7, No. 1, 67-72 (1961). In Russian.

The problem of transmission of purely flexural waves fro arbitrary semi-infinite rod to another through an intermediate is studied, given that the rods are joined rigidly end-to-end. T reflection and transmission coefficients are determined in the general case and in special cases of practical interest. The pe bility is examined of a substantial simplification of the analysis the case of an intermediate rod whose length is more than half flexural wavelength. The conditions for no reflection from the intermediate rod are considered, and it is demonstrated under conditions this rod can play the role of a matching insert, the a of a translucent layer in optics. [English translation in: Sovi Physics—Acoustics (USA), Vol. 7, No. 1, 50-5 (July-Sept., 1961

16000 ATTENUATION OF FLEXURAL WAVES IN RODS A PLATES BY MEANS OF RESONANCE VIBRATING SYSTEMS. I.I.Klyukin.
Akust. Zh. (USSR), Vol. 6, No. 2, 213-19 (1960). In Russian.

An investigation is made of the vibration-isolating effect o resonance vibrating systems (antivibrators) with respect to fle waves propagating in rods and plates. As opposed to vibration-arresting masses, an antivibrator having an inertial impedance lateral displacements only is capable of providing the same vib tion isolation as an antivibrator with impedance to rotational di placements. For an antivibrator with lateral displacements, th frequency of the vibration isolation maximum is higher than the partial frequency of the antivibrator, whereas for an antivibrat with impedance to translational motion is it lower than the cor ponding partial frequency. It is shown experimentally that antivibrator with a rubber elastic element, when set up on thin metal plates, has a vibration-isolating effect in a certain frequ range. [English translation in: Soviet Physics—Acoustics (US Vol. 6, No. 2, 209-15 (Oct.-Dec., 1960)].

16001 PENETRATION OF A SHORT STRESS PULSE FRO RIGID INTO A PLASTIC ROD.
F.F.Vitman, B.S.Ioffe and G.S.Pugachev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 435-44 (Sept., 1960). In Russian.

Mechanical deformation pulses of 10^{-5} sec duration were applied to steel rods. The amplitude of the transmitted pulses depended on the composition and mechanical properties of the and on whether the rod end to which the pulses were applied wa plastically deformed or not. A.Tybul

16002 ATTENUATION AND DISPERSION OF ELASTIC W IN A CYLINDRICAL BAR.
J.Zemanek, Jr and I.Rudnick.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1283-8 (Oct., 1961).

The resonance method was used to study the attenuation an dispersion of the first longitudinal mode of propagation and the dispersion of the first flexural mode of propagation of elastic w in a cylindrical, aluminium alloy (24ST) rod. Q was found to de crease monotonically from 2.5×10^5 to 1.2×10^5 as the freque increased from 0.84 to 100 kc/s. Longitudinal and flexural pha velocities are compared with Pochhammer—Chree theory dis-persion curves. Agreement of experimental and theoretical cu is within 0.3%. Similar agreement is obtained when normal fle modes computed by a modified Timoshenko theory are compare the experimental resonant frequencies. Measurements of torsi mode frequencies indicate dispersion does not exceed approxim 0.01% in the frequency range of approximately 0.5 to 100 kc/s.

03. ATTENUATION OF RAYLEIGH WAVES ON CYLINDRICAL SURFACES. I.A.Viktorov.
Zh. (USSR), Vol. 7, No. 1, 21-5 (1961). In Russian.
n experimental investigation established that on a concave
rical surface, Rayleigh waves suffer an additional (in compari-
th a plane surface) attenuation, the magnitude of which is
ined by the curvature of the surface. No additional attenua-
this sort is observed on a convex cylindrical surface.
sh translation in: Soviet Physics—Acoustics (USA), Vol. 7,
13-16 (July-Sept., 1961)].

004 TRANSMISSION AND REFLECTION OF RAYLEIGH WAVES BY ROUNDED EDGES OF VARIOUS RADII.
iktorov.
. Zh. (USSR), Vol. 7, No. 1, 90-1 (1961). In Russian.
The paper gives some results of an experimental study of the
mission and reflection of Rayleigh waves by cylindrical
led edges with a radius of 0-1.7λ (λ being the Rayleigh
length) formed between the faces of a rectangular elastic
e. Details of the method used are given and the results lead
conclusion that for $0<r/\lambda<1.7$ the transmission and
ction of Rayleigh waves by a rounded edge is determined by
atio r/λ, while for $r/\lambda>1.7$ the transmission and reflection
icients become almost equal to 1 and 0 respectively, i.e.
l" transmission of the Rayleigh waves over the rounded
on occurs. [English translation in: Soviet Physics—Acoustics
J, Vol. 7, No. 1, 70-1 (July-Sept., 1961)]. B.Brown

005 PLANE THERMO-ELASTIC WAVES IN AN INITIALLY STRESSED MEDIUM. J.N.Flavin and A.E.Green.
ech. Phys. Solids (GB), Vol. 9, No. 3, 179-90 (July, 1961).
The propagation of plane thermoelastic waves of small ampli-
in an infinite body is studied, the body having been subjected to
uniform extensions, at constant temperature, in three perpen-
ar directions, two of the extension ratios being equal.

6006 A NOTE ON THERMOELASTIC RAYLEIGH WAVES. H.Deresiewicz.
ech. Phys. Solids (GB), Vol. 9, No. 3, 191-5 (July, 1961).
The propagation of waves on the surface of an elastic thermally
ucting medium, which has been the subject of two recent papers,
-examined herein, and expressions are displayed which exhibit
requency dependence of the phase velocity and amplitude attenua-
It is shown that the order of magnitude of the frequency de-
ence is a function of the heat-transfer coefficient at the bound-

6007 THE PROPAGATION OF ELASTO-PLASTIC WAVES IN COMPLEX LOADING. Kh.A.Rakhmatulin.
lad. Mat. i Mekh.(USSR), Vol. 22, No. 6, 759-65 (1958).
ussian.
The nature of the wave propagation corresponding to a
icular law of elasto-plastic deformation is examined in the
owing cases: compressional-shear (oblique) impact of two free
s; compressional-shear impact of two bars between rigid
es; torsional-compressional impact, produced by the impact of
hollow cylinders, one of which is rotating and moving relative
ne other. R.F.S.Hearmon

6008 SURFACE WAVES IN ANISOTROPIC ELASTIC MEDIA. V.T.Buchwald and A.Davis.
re (GB), Vol. 191, 899-900 (Aug. 26, 1961).
Using a Fourier transform method and electronic computation,
surface wave curves for iron in the (100) and (110) planes are
ulated. In the (100) plane, surface waves are confined to four
ges of angle about 45° containing the fourfold axes. In the (110)
ne, surface waves are propagated in all directions. The laws
erning the damping of the wave amplitudes with depth and orien-
on are discussed. R.F.S.Hearmon

AN ITERATION-VARIATION METHOD FOR WAVE PROPAGA-
N PROBLEMS. See Abstr. 16579

INTERRELATION BETWEEN THE THEORY OF DISLOCA-
NS AND FINITE AMPLITUDE WAVE PROPAGATION IN
LIDS. See Abstr. 14[illegible]

ELASTIC WAVE PROPAGATION IN A RELAXING SOLID.
Abstr. 14297

ACOUSTICS

16009 SOME INTEGRAL EQUATIONS IN THE ACOUSTICS OF A MOVING MEDIUM. L.M.Lyamshev.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 3, 575-8 (May 21, 1961).
In Russian.
It is possible to derive equations for the acoustics of moving media that to some extent are analogous to equations of reciprocity, although, of course, the principle of reciprocity does not apply in moving media. The solutions to these equations relate volume sources and surface forces acting on thin elastic bodies in a moving medium to the sound fields caused by the sources and by vibration of the elastic bodies. [English translation in: Soviet Physics—Doklady (USA) Vol. 6, No. 5, 410-12 (Oct., 1961)].
J.M.Taylor

16010 THE ACOUSTIC RADIATION OF TURBULENT FLOW IN THE PRESENCE OF ELASTIC BOUNDARIES. L.M.Lyamshev.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 6, 1343-6 (April 21, 1961).
In Russian.
The equation derived by Lighthill (Abstr. 3372 of 1952; 3188 of 1954) is used as a basis for computing the radiation of sound by turbulent aerodynamic flow around streamlined elastic bodies (plates, rods, etc.) extended in the direction of flow. The solution shows that turbulent flow around elastic bodies in the stream produces superimposed fields of radiation from volume sources caused by fluctuations of pressure and viscous stress in the stream and fields from the surfaces of the bodies. The surface sources consist of fluctuations of pressure and viscous stress and fluctuations of speed at the surface of the bodies. Dimensional analysis leads to the conclusion that the field of the volume (quadrupole) sources is proportional to the eighth power of the ratio of speed of flow to speed of sound in the medium (M^8); the field of the surface (dipole) sources is proportional to M^6, and of simple sources to M^4. The results reported by Doak (Abstr. 8684 of 1960) and Powell (Abstr. 14768 of 1960) are found to be particular cases of the more general solution found here. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 4, 341-3 (Oct., 1961)]. J.M.Taylor

SOUND RADIATION OF DAMPED AND UNDAMPED FLAT PLATES. See Abstr. 15991

16011 SOUND RADIATION FROM ELASTIC SHELLS EXCITED BY TURBULENT AERODYNAMIC FLOW. L.M.Lyamshev.
Akust. Zh. (USSR), Vol. 7, No. 1, 59-66 (1961). In Russian.
An approximate calculation is given for the field generated by infrasonic turbulent flow outside or inside thin elastic shells in the flow itself. It is shown that the calculation reduced to solving the auxiliary diffraction problem and defining the velocity or pressure fluctuation correlation tensor in the flow and on the surface of the shell. When the auxiliary solution and corresponding correlation function are known it is only necessary to calculate the square. The mean square pressure fluctuation in the acoustic field radiated by a moving thin plate oscillating under the action of pressure fluctuations in the boundary layer is calculated approximately. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 44-9 (July-Sept., 1961)].

16012 FLOW NOISE IN WATER-FILLED TUBES. E.Meyer, A.Dinkelacker and K.Tamm.
Acustica (Internat.), Vol. 10, No. 5-6, 322-5 (1960).
A simple arrangement is used for the investigation of flow noise generated by streaming water in thin-walled, smooth tubes. With turbulent flow in the tube broad-band noise is found; there is a simple relation between the noise spectrum and the flow velocity. In the range of the critical Reynolds number "noise shots"are observed when the flow changes between laminar and turbulent flow.

16013 EFFECT OF AN INTERMEDIATE LAYER ON THE FREQUENCY CHARACTERISTICS OF ULTRASONIC DELAY LINES. K.S.Aleksandrov, L.S.Gurovits and E.I.Kamenskii.
Akust. Zh. (USSR), Vol. 6, No. 2, 171-9 (1960). In Russian.
General expressions are derived for the conversion factor of a line, taking into account the influence of an intermediate layer in the case of one-sided and symmetric transducer loads. The effect of the relation between the specific acoustic impedances of the transducer,

acoustic line, and intermediate layer, as well as the thickness of the latter on the frequency characteristics and transmission band of the line is demonstrated. Recommendations are made for obtaining lines with a broad transmission band. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 170-7 (Oct.-Dec., 1960)].

16014 TRANSIENT PROCESSES IN THE ACOUSTIC FIELDS GENERATED BY A PISTON MEMBRANE OF ARBITRARY SHAPE. O.G.Kozina and G.I.Marakov.
Akust. Zh. (USSR), Vol. 7, No. 1, 53-8 (1961). In Russian.

Considers the transient processes created by a plane piston membrane in a rigid wall with a fairly arbitrary convex contour. If, in addition, the membrane has an axis of symmetry in the plane of the wall and its contour is described by an analytic function, the field for all forms of membranes in the vicinity of the wavefronts will be described by certain standard functions. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 39-43 (July-Sept., 1961)].

16015 OBSERVATIONS OF THE STABILITY OF A NORMAL MODE SOUND FIELD IN AN INTERMEDIATE SCALE MODEL. J.A.Scrimger.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1329-33 (Oct., 1961).

Spectra of sound-pressure amplitude versus frequency in the range 1.1 to 2.4 kc/s were obtained at regular intervals in shallow (10 ft) water during two periods of extended observation. The acoustical data are presented in the form of contour diagrams of sound-pressure amplitude versus frequency and time as coordinates and compared with water conditions. The form of the contour diagrams permits differentiation between field-structure variation and variation in attenuation although differentiation between the associated processes has not been possible. Temporal variation in the vertical sound-velocity profile produced only small changes in the gross features of the field structure, as inferred from the contour diagram, for up to the first three modes of propagation. For frequencies above 1.6 kc/s (i.e. when three or four modes were stimulated) the variations in field structure were prominent. Attempts were made, with little success, to explain periods when the received signal was strongly attenuated in terms of vertical sound-velocity structure.

16016 PLATE WAVES IN A THREE-LAYER MEDIUM. F.I.Kryazhev and N.A.Petrov.
Akust. Zh. (USSR), Vol. 6, No. 2, 229-36 (1960). In Russian.

Experimental data are presented on the propagation of a first-order plate wave (first normal mode) in a layer of water lying on top of a complex bottom consisting of a surface layer and underlying homogeneous half space with different acoustic properties. It is found that for the given type of bottom, waveguide propagation sets in for $kh > 2.8$, where k is the wave number of acoustic waves in the layer of water, h is the depth of the same layer. The value of the critical frequency is determined, for which plate waves are first propagated in the water layer. A comparison is made between the experimental and theoretical data. The velocity of sound in the surface layer of the bottom was computed from the value of the reflectivity, which was found by the standing wave method; the velocity of sound in the lower homogeneous half space was found from the phase velocity of the first plate wave. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 225-32 (Oct.-Dec., 1960)].

16017 SOUND PROPAGATION IN A WAVEGUIDE HAVING [ONE OR TWO] RECTANGULAR GROOVES IN THE WALLS. A.D.Lapin.
Akust. Zh. (USSR), Vol. 6, No. 2, 237-43 (1960). In Russian.

The acoustic fields in the waveguide and in the groove are sought in the form of an expansion in appropriate eigenfunctions. These fields are matched at the boundary of the waveguide and groove to obtain an infinite system of algebraic equations with constant coefficients. This system of equations is solved numerically by a reduction method for certain values of the parameters of the waveguide and groove. The optimum size of the groove for which the greatest reflection of sound is obtained and the frequency characteristics of the waveguide with the groove are found. A comparison is made between theory and experiment. The limits of applicability of the approximate theory, without taking the effect of groove width into account, are shown. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 233-8 (Oct.-Dec., 1960)].

16018 EXPERIMENTAL INVESTIGATION OF THE FIELD IN ONE INSTANCE OF ANTIWAVEGUIDE PROPAGATION OF SOUND. A.N.Barkhatov and S.P.Myasnikov.
Akust. Zh. (USSR), Vol. 7, No. 1, 18-20 (1961). In Russian.

The acoustic field in a laminar medium having a sound velocity maximum below the surface level of the liquid is investigated. It is shown experimentally that at the level of the maximum and below it there is formed a geometric shadow zone, which goes over to space with a spherical sound attenuation law, regardless of the numerical value of the sound velocity gradient. Above the velocity maximum, a surface channel is formed in which the variation of intensity with distance from the radiator follows a cylindrical law. [English translation in: Soviet Physics-Acoustics (USA), Vol. 7, No. 1, 11-12 (July-Sept., 1961)].

16019 STUDY OF THE FIELD STRUCTURE OF A CYLINDRICAL ULTRASONIC CONCENTRATOR. I.N.Kanevskii.
Akust. Zh. (USSR), Vol. 7, No. 1, 40-6 (1961). In Russian.

An expression is obtained for the potential of an infinite converging cylindrical wave front, and with this expression the distribution in absolute value of the potential and equiphase lines in the focal region are constructed. The difficulties involved in using Green's formula to compute the fields of radiators are discussed. The effect of the height of a radiator (of finite dimensions) on the field at the middle of its axis is considered. The field structure in the focal region of a cylindrical radiator is investigated experimentally. The experimental results are compared with theory. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 29-33 (July-Sept., 1961)].

16020 WIDTH OF A SAWTOOTH WAVEFRONT. E.V.Romanenko.
Akust. Zh. (USSR), Vol. 7, No. 1, 103 (1961). In Russian.

Making use of the experimental data on the spectral composition of acoustic sawtooth waves Zarembo (Abstr. 19309 of 1960) concluded that the sawtooth wavefront width differed considerably from the width of the front of weak shock waves. The present author carried out a more careful investigation of the spectral composition of acoustic sawtooth waves in order to explain the large disparity in the results obtained by Zarembo. The author's results showed that the equation used by Zarembo led to a coarse determination of the harmonic components of an acoustic sawtooth wave as far as the 30-th harmonic with an accuracy of 15-20%. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 82-3 (July-Sept., 1961)]. B.E.

16021 EFFECT OF A THIN ELASTIC LAYER ON THE PROPAGATION OF [LOW-FREQUENCY] SOUND IN A LIQUID HALF-SPACE. V.N.Krasil'nikov.
Akust. Zh. (USSR), Vol. 6, No. 2, 220-8 (1960). In Russian.

It is shown that a point source excites a surface flexural wave at the boundary between the half-space and plate. The properties of this wave are analysed, and it is demonstrated that under definite conditions this wave constitutes the principal part of the sound field near the surface. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 216-24 (Oct.-Dec., 1960)].

16022 THEORY OF SOUND PROPAGATION IN A FLOW DUCT. K.Schuster.
Acustica (Internat.), Vol. 10, No. 5-6, 326-9 (1960). In German.

Solutions of Navier—Stokes equations are discussed which correspond to the superposition of sound waves with laminar flow in a duct with two plane, rigid walls. Sound waves with a spatial exponential increase of amplitude are found under certain conditions.

16023 ENERGY RELATIONS IN SOUND PROPAGATION IN POROUS MATERIALS WITH RIGID SKELETON. F.Kolmer and J.Tichý.
Czech. J. Phys., Vol. 10, No. 11, 872-9 (1960).

The paper deals with the determination of the frequency dependence of the acoustic resistance, of the structure factor, the porosity factor and the constant giving whether the process in the propagation of sound in porous materials with a rigid skeleton is isothermal, adiabatic or polytropic. The latter dependence enables a conclusion to be reached on the energy relations during sound propagation in porous materials. The derivation of the wave resistance and of the constant of wave propagation in a porous material with a rigid skeleton is given and a method described for calculating the co

characterizing the material on the basis of measurements of e resistance and the acoustic impedance of the material. The tion was carried out for felt and it was found that the acoustic nce and structure factor depends on the frequency and that the s at low frequencies approaches the isothermal and at high ncy the adiabatic. It is shown that the structure factor is not o unity even in order of magnitude, as is often assumed in the ure. It is shown that for a complete knowledge of the acoustic nce necessary for the calculations it is not enough to deter- t by the static method.

24 ACOUSTIC PROPAGATION IN A TWO-LAYERED MODEL — TRANSVERSE WAVES IN BOTTOM.
oy and A.O.Williams.
ust. Soc. Amer., Vol. 33, No. 10, 1427-8 (Oct., 1961).
he complex shear modulus of Hycar rubber was determined coustical measurements, over a wide range of frequencies mperatures. From these data and the density of the rubber, eed of transverse waves was computed. Results are com- with values inferred in a previous paper (Abstr. 2196 of when the rubber was used as the bottom material in a model- test of shallow-water propagation. Discrepancies are 15%.

025 AN APPROXIMATION TO THE REMAINDER OF ROBEY'S REACTIVE IMPEDANCE INTEGRAL.
reenspon.
oust. Soc. Amer., Vol. 33, No. 10, 1428-9 (Oct., 1961).
procedure is outlined for computing the remainder of Robey's ive impedance integral (Abstr. 7787 of 1955) for the self and al impedance of rings on an infinitely long rigid cylindrical . It is assumed that numerical integration has been carried a given point. The remainder of the infinite integral is then uted in terms of the well known sine and cosine integrals have already been tabulated in the literature.

QUANTUM-MECHANICAL MANY-PARTICLE TREATMENT OF D PROPAGATION. See Abstr. 15743

AN ITERATION-VARIATION METHOD FOR WAVE PROPAGA- PROBLEMS. See Abstr. 16579

3026 THE VELOCITY OF SOUND IN ALUMINIUM AND COPPER BARS. C.Sălceanu.
. Acad. Sci. (France), Vol. 252, No. 20, 3021-3 (May 15, 1961).
rench.
Previous work (Abstr. 5081 of 1960) is extended to bars of inium and copper, the velocity of sound being studied in these ls between 20° and 375°C. A decrease with increasing temper- is found. Effects of heat treatment on velocity are also ied. L.Mackinnon

.6027 VARIATION OF THE VELOCITY OF SOUND WITH TEMPERATURE IN BARS OF STEEL.
ilceanu and M.Zăgănescu.
. Acad. Sci. (France), Vol. 252, No. 16, 2385-6 (April 17, 1961).
rench.
Reference is made to a previous paper by Salceanu and chitt (Abstr. 5081 of 1960) in which measurements of ocity in steel bars were made over the temperature range to 366°C. It is now shown that these measurements, extended to °C, agree with those calculated from tables of Young's ulus (E) at different temperatures using the well known relation $(E/\rho)^{1/2}$ where ρ is the density and v is the velocity of longitudi- waves. The method used to measure v is the "displacement of principal band of acoustic resonance" for each temperature sidered. A.B.Wood

16028 INTERNAL REFLECTIONS AND LOW FREQUENCY CUTOFF IN NONUNIFORM TRANSMISSION STRUCTURES.
.Holte and R.F.Lambert.
Acoust. Soc. Amer., Vol. 33, No. 9, 1246-7 (Sept., 1961).
The authors have previously published a paper on the "Synthesis stepped acoustic transmission systems". (Abstr. 5325 of 1961). eir explanation of the application of the synthesis procedures eloped for stepped systems to a smoothly tapering structure over ide range of frequencies resulted in some misunderstanding and rther letter by Young and Young (Abstr. 9442 of 1961) clarified ir statements. In this paper, the authors state that they agree with comments of Young and Young that when all internal reflections are accounted for, the stepped structure in the limit of many infinitesimal steps will display properties of a continuous structure. It is pointed out that the inability of the linear model to account for low frequency cutoff in a smoothly tapered structure is a limitation in its general utility for purposes of analysis and synthesis. This limitation is illustrated by considering the exponential tapered structure. B.Brown

16029 EXPERIMENTAL STUDY OF DIFFRACTION AND WAVEGUIDE EFFECTS IN ULTRASONIC ATTENUATION MEASUREMENTS.
E.F.Carome, J.M.Witting and P.A.Fleury.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1417-25 (Oct., 1961).
An experimental study was made of the propagation of ultrasound in liquids under both free-field and guided-wave conditions. Free-field measurements were made from 1 to 20 Mc/s in low absorbing liquids, employing both circular and square sound sources. These measurements indicate the the correction for diffraction loss predicted by existing theories is applicable only so long as this loss is smaller than the true absorption. Attenuation measurements also were made in liquids confined in various cylindrical and rectangular metallic waveguides. For a given configuration, the observed variation with path length of the attenuation follows closely that predicted theoretically for propagation in a solid sample of the same dimensions. Some consideration is given to possible sources of this result which differs somewhat from the predictions of current theories.

DIFFRACTION OF ELECTROMAGNETIC WAVES BY SOUND WAVES. See Abstr. 16564

DIFFRACTION OF LIGHT BY UNDAMPED AND DAMPED ULTRASONIC WAVES. See Abstr. 16108

16030 COMMENT ON "EXPERIMENTAL STUDY OF THE SCATTERING OF ACOUSTIC ENERGY FROM SOLID METAL SPHERES IN WATER". R.R.Goodman.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1428 (Oct., 1961).
Hampton and McKinney recently reported (Abstr. 6936 of 1961) that the backscattered target strength from a sphere is essentially invariant for short pulses but fluctuates rapidly for long pulses as the frequency is changed by a few percent. By a Fourier transform analysis it is shown that the above result is to be expected. A small change in frequency does not significantly change the transform of the short pulse but drastically shifts the long-pulse transform. The argument only holds if the steady-state scattering amplitude is rapidly varying over the frequency range considered, a condition which is met by the Hampton and McKinney experiment.

16031 SCIENTIFIC PRINCIPLES OF VIOLIN MAKING: SURVEY. G.Meinel'.
Akust. Zh. (USSR), Vol. 6, No. 2, 147-61 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 149-61 (Oct.-Dec., 1960).

16032 COMPARISON OF THE ACOUSTICAL PERFORMANCE OF CALFSKIN AND PLASTIC DRUMHEADS.
H.C.Hardy and J.E.Ancell.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1391-5 (Oct., 1961).
Reports acoustical differences found for drumheads made of Mylar plastic instead of the conventional calfskin. Two identical bass drums and two identical field drums were fitted with heads of the two materials. A professional drummer was engaged to adjust and play these drums with several tension adjustments. A tape-recorded analysis was made of their sounds, including single impact beats and steady rolls. The sound spectra of the quasi-steady-state drum rolls were determined by half-octave bands, by a method similar to that of Sivian, Dunn, and White. Spectra of the peak sound-pressure levels were obtained with an impact sound analyser. The buildup and decay of the drum sounds were analysed in chosen frequency bands by use of a high-speed level recorder. The chief physical differences found are: (1) the calfskin head is capable of a much larger range of tension adjustment, and (2) under certain conditions it has more damping. When the bass drum is tuned to concert tightness, there is a significant difference between the spectra of the plastic and calfskin drumheads and in the time variation of sound output. For the field drum there is little spectral difference, but the calfskin gives a more staccato beat with less "metallic" ringing.

16033 INVESTIGATION OF THE MODE OF VIBRATION OF A RESONANCE BOX. A.Keller.
Acustica (Internat.), Vol. 10, No. 5-6, 372-80 (1960). In German.

The mode of vibration of a trapezoidal resonance box was investigated. Besides the classical nodal lines observed at low frequencies, nodal points are found for frequencies of about 800 c/s and more. Around these nodal points the phase is continuously changing from 0^0 to 360^0. Nodal points are explained from a simple model with two superimposed systems of standing bending waves with orthogonal privileged directions. From the measuring results and their interpretation the mean natural frequencies of the resonating body are calculated. This enables theoretical conclusions to be drawn with respect to the acoustical properties of the box.

16034 A SIREN FOR THE ACOUSTIC COAGULATION OF AEROSOLS. S.A.Tsedilin and V.M.Tsetlin.
Akust. Zh. (USSR), Vol. 7, No. 1, 78-86 (1961). In Russian.

The design specifications and the gas dynamic and acoustic characteristics are presented of a siren developed, assembled and tested at the State Institute of Nonferrous Metals. An investigation of the acoustic field generated by the siren in a coagulation column 610 mm in diameter showed that the acoustic energy flux reaches 3240 W at a frequency of 3.9 kc/s and a distance of 3.1 m, with a mass flow of air equal to 451 Nm^3/hr and a pressure of 699 mm Hg. The generator in question makes it possible to generate an acoustic field over the range of frequencies and sound intensity levels necessary for the acoustic coagulation of aerosols. [English translation in: Soviet Physics—Acoustics (USA), Vol. 7, No. 1, 60-6 (July-Sept., 1961)].

ACCELERATING ACTION OF SOUND ON THE DEVELOPMENT OF A PHOTOGRAPHIC EMULSION. See Abstr. 16127

Instruments and Measurements

16035 DIFFRACTION OF SOUND IN THE ACOUSTIC PATH OF A PULSE-TYPE FLAW DETECTOR. I.N.Ermolov.
Akust. Zh. (USSR), Vol. 6, No. 2, 198-204 (1960). In Russian.

The influence of diffraction effects on the signal amplitude of an ultrasonic pulse flaw detector is investigated. For the solution of the problem, approximate boundary conditions of the Kirchhoff type are employed. The limits are established, within which the acoustic path of the flaw detector in a solid (metal) can be replaced by a fluid model. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 195-201 (Oct.-Dec., 1960)].

16036 APPLICATION OF FREQUENCY MODULATION TO ACOUSTICAL MEASUREMENTS.
V.A.Zverev and A.I.Kalachev.
Akust. Zh. (USSR), Vol. 6, No. 2, 205-12 (1960). In Russian.

Experiments were conducted on the application of frequency modulation under conditions of continuous radiation for acoustical measurements in live rooms. The method given was used in conjunction with a spectrum analyser and correlation functions to determine the location of sources of sound and reflections. In the example of analysis of oscillations with a linearly increasing frequency, it is shown by the spectral and correlation methods that the correlation procedure makes it easy to discern discrete sources of reflection from reverberation signals. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 202-8 (Oct.-Dec., 1960)].

16037 PRESSURE CALIBRATION OF MEASURING MICROPHONES BY THE RECIPROCITY METHOD.
A.N.Rivin and V.A.Cherpak.
Akust. Zh. (USSR), Vol. 6, No. 2, 252-60 (1960). In Russian.

The method enables the microphone sensitivity to be read directly from an attenuator, correct to 0.1 dB. The method is based on the direct measurement of the ratio of the voltage imposed on a bidirectional transducer operating as a radiator to the "no-load" voltage arising in its associated circuit under the action of the acoustic pressure created by the same transducer operating as a radiator. The measurements are performed in a small closed chamber, the walls of which are made from piezoceramic and serve as an auxiliary radiator, permitting calibration without having to resort to a rearrangement of the transducers. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 246-53 (Oct.-Dec., 1960)].

16038 CERTAIN ASPECTS OF THE OPERATION OF AN ELECTRON-ACOUSTIC IMAGE CONVERTER.
Yu.B.Semennikov.
Akust. Zh. (USSR), Vol. 7, No. 1, 73-7 (1961). In Russian.

Certain problems involved in the selection of load impeda for electron-acoustic converters (EAC) are discussed. The o ting characteristics of EAC at high-frequencies are investigat is shown that the sensitivity of an EAC frequently depends on choice of material for the piezoelectric plate. A comparison existing piezoelectric materials shows that the best electrom ical parameters for EAC are found in barium titanate and Y-c lithium sulphate. [English translation in: Soviet Physics—Ac (USA), Vol. 7, No. 1, 56-9 (July-Sept., 1961)].

16039 PHASE COMPARISON INTERFEROMETER FOR T MEASUREMENT OF SOUND VELOCITY CHANGE LESS THAN 1 MM/S. W.Schaaffs and C.Kalweit.
Acustica (Internat.), Vol. 10, No. 5-6, 385-93 (1960). In Germ

A very sensitive phase comparison interferometer with fi plate separation was developed for the experimental investigat a number of fine-structure problems of the velocity of sound. r.f.-voltage of 4.04 Mc/s was generated by an oscillator and s through two different channels into the x-plates and y-plates r spectively of an oscilloscope. In this special case the Lissajo ellipse degenerates into a straight line. One of the channels c tains an ultrasonic path through a liquid, the sound velocity of changes due to certain effects. The other channel consists of phase regulator. Very small and fast changes of the velocity sound may be observed by the splitting up of the straight line ellipse. Velocity changes can be measured with an accuracy o mm per sec.

16040 A NEW ULTRASONIC INTERFEROMETER OF TH FABRY—PÉROT TYPE. G.Laville.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3417-19 (May 29, 1
In French.

A plane-parallel beam of sound waves was produced by a piezoelectric transducer in water. The beam was passed thro etalon using duralamin plates and a variable spacing, and then detected by means of a small pendulum. The etalon can be fill with any liquid under test. Two sample curves showing the type readings are given. H.D.Par

16041 CERAMIC CAPACITORS AS SOUND PROBES IN LIQUIDS. H.J.Schmitt.
Rev. sci. Instrum. (USA), Vol. 32, No. 2, 215-17 (Feb., 1961).

The conversion of a commercial 2000 $\mu\mu$F ceramic capac to an extremely small and inexpensive sound probe is describe The sensitivity of this and other small capacitors (up to 3000 was studied in liquids with regard to frequency and to the mag and direction of polarization. A sensitivity of −150 dB relativ 1V/μbar is quoted for the 2000 $\mu\mu$F capacitor with 112.5 V 100 bias. Only in the low ultrasonic frequency range, however, is capacitor response truly omnidirectional. J.D.

16042 ACCURACY OF SOUND ABSORPTION COEFFICIE IN REVERBERATION CHAMBERS.
H.G.Andres and D.Brodhun.
Acustica (Internat.), Vol. 10, No. 5-6, 330-5 (1960). In Germa

The essential errors associated with the measurement of absorption coefficients by the reverberation room method are cussed. An analysis of the statistical errors gives their princ sources and experiments show the range of repeatability. This compared with reproducibility deduced from the result of a ro robin-measurement. A connection between the spatial distribu of reverberation times and diffusion is pointed out.

16043 CONTRIBUTION TO THE PROBLEM OF DIFFUSE OF THE SOUND FIELD IN A REVERBERATION CHAMBER. F.Kolmer, M.Krňák and J.Tichy.
Acustica (Internat.), Vol. 10, No. 5-6, 357-71 (1960). In Germ

Deals with the influence of the diffuseness of the sound fie a reverberation chamber on the sound absorption coefficient. diffuse sound field was obtained with the help of cylindrical sc ers suspended in the reverberation room. It is shown that for verberation chambers of a size as recommended by the ISO it better to use a larger number of smaller elements. However, scattering elements should be large enough to be already effec at the limiting frequency of the reverberation room. The scat objects must be distributed equally over the room with arbitra orientation relative to each other and to the walls. Measurem

made in two reverberation rooms supplied with scattering nts. The measured sound absorption coefficients differed by ore than 10%. Furthermore the relation of Meyer and uff (Nachr. Akad. Wiss. Göttingen, math.-phys. Kl. (Germany), No. 6.) for the limiting frequency of reverberation rooms ed from measurements with model reverberation chambers, onfirmed for rooms of a size as recommended by the ISO. It ound that rotating loudspeakers with reflector plates did not ove the diffuseness of the sound field or the conditions of urement. Increased diffuseness reduces the scatter of ured values of reverberation time especially at low frequencies. is explained by the increased attenuation of the natural frequ- s of the rooms. Oblique walls produce a more even distribution e natural frequencies whose number is the same as in a com- ble room with parallel walls. The obliquity of the walls also lts in a reduction in the variation of measured sound pressure position of the microphone. A further reduction in this variation hieved in both reverberation chambers by the suspended scatter- lements.

6044 INTERNATIONAL COMPARISON MEASUREMENTS IN THE REVERBERATION ROOM. C.W.Kosten.
tica (Internat.), Vol. 10, No. 5-6, 400-11 (1960).
ISO TC 43 has undertaken the task to draw up an international dard for the measurement of sound absorption in the reverbera- room. This publication is a report of extensive international parison measurements, carried out to supply the necessary mation for such a standard. The results are: (1) a sample of m^2 is desirable; (2) such a sample requires a room of not less about 180 m^3, in which a large number of large diffusing ents are installed in order to provide a really diffuse reverber- ield; (3) the remaining discrepancies between the various utes are probably mainly due to variations in edge effect. The r point is in need of further study.

ise . Architectural Acoustics

6045 NOISE FROM CAVITATING SUBMERGED WATER JETS. D.W.Jorgensen.
coust. Soc. Amer., Vol. 33, No. 10, 1334-8 (Oct., 1961).
Frequency spectra of the underwater noise produced by cavita- submerged water jets were determined experimentally for zle diameters from $\frac{3}{8}$ to $1\frac{1}{2}$ in., efflux velocities from 40 to ft/sec, and ambient pressures up to 2 atm. When cavitation is ely incipient, the r.m.s. sound pressure varies with differences he manner of handling the water prior to a run; this variation of nd pressure is presumably due to changes in the nuclei content he water. When, however, the cavitation index is sufficiently ull, cavitation is well advanced, and then the radiated sound is pendent of the manner of treating the water. For this condition mple relation is found to exist among the noise spectra when they plotted as dimensionless functions of those physical quantities ch determine the flow.

6046 OPTIMUM REVERBERATION TIME FOR SPEECH ROOMS BASED ON HEARING CHARACTERISTICS. A.A.Lochner and J.F.Burger.
stica (Internat.), Vol. 10, No. 5-6, 394-9 (1960).
Optimum reverberation time has been used as a criterion for design of speech rooms for many years and will probably be used such for many more years to come. The present investigations wed, however, that reverberation time is no measure of the ellence of a speech room but is in fact a secondary effect which ends on the same physical conditions which, in combination with tain hearing characteristics, determine the intelligibility of ech in a room. By making certain assumptions the optimum erberation times for speech rooms were calculated from the gration and masking characteristics of the hearing mechanism were found to be in good agreement with previously assumed ues based on empirical judgments.

OPTICS . PHOTOMETRY

16047 ERGODIC THEOREM IN THE SOLUTION OF THE SCALAR WAVE EQUATION WITH STATISTICAL BOUNDARY CONDITIONS. T.J.Skinner.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1246-51 (Nov., 1961).
By assuming the random, time-varying boundary conditions for the scalar wave equation to be ergodic, the time-varying boundary conditions and an ensemble of strictly monochromatic boundary conditions can be associated. Formally solving and comparing the solutions for each type of boundary condition leads to the conclusion that the time-averaged and ensemble-averaged powers (squares of the field) are the same at all points where the path difference to any two points on the boundary is small compared to $c/\Delta\nu$, where c is the free-space speed of light and $\Delta\nu$ is the frequency spread of the time-varying boundary conditions. That is, if the boundary conditions are ergodic, the solutions are ergodic.

16048 COHERENCE PROPERTIES OF ELECTROMAGNETIC RADIATION. E.L.O'Neill and L.C.Bradley.
Phys. Today (USA), Vol. 14, No. 6, 28-34 (June, 1961).
Report of a conference held in June 1960 at the University of Rochester and sponsored by the U.S. Air Force, the University of Rochester and the Optical Society of America. The purpose of the conference was to bring together optical and atomic physicists from this country and abroad to discuss problems of common interest dealing with the question of coherence throughout the electromagnetic spectrum.

THE ENERGY–MOMENTUM TENSOR OF AN ELECTROMAGNETIC FIELD IN AN OPTICALLY ACTIVE MEDIUM.
See Abstr. 16577

16049 NEUTRAL OPTICAL ATTENUATORS. P.A.Newman and R.Binder.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 351 (March, 1961).
Two wire screens of different meshes were placed in series. The attenuation could be adjusted to a chosen value within the range 0.6 to 0.1 and it was neutral over the wavelength range from the visible to 4μ. W.T.Welford

16050 TECHNIQUE FOR CALCULATING INFRARED ABSORPTANCE BY A REGULAR BAND. L.R.Megill and P.M.Jamnick.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1294-7 (Nov., 1961).
An analytical technique which can be used to derive effective total line intensities in a regular band has been developed. These intensities can, in turn, be used to calculate atmospheric transmittance. The calculations are of such length that electronic computers are required for the work. The results are given in terms of an atmospheric absorption curve which agrees well with the experimental data.

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

16051 DYNAMIC PROGRAMMING, FERMAT'S PRINCIPLE AND THE EIKONAL EQUATION. R.Kalaba.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1150-1 (Oct., 1961).
Shows how the eikonal equation for optical wave-fronts may be derived directly from Fermat's principle of least time by an elementary application of Bellman's principle of optimality (from the dynamic programming technique of operational research). A.J.McTernan

16052 SKEW RAY TRACING THROUGH TORIC REFRACTING SURFACES. J.Becker.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 156-60 (1961).
A simplified method for skew ray tracing through toric refracting surfaces is described and formulae are given.

16053 INTEGRATING SPHERE FOR IMPERFECTLY DIFFUSE SAMPLES.
D.K.Edwards, J.T.Gier, K.E.Nelson and R.D.Roddick.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1279-88 (Nov., 1961).

An integrating sphere for determining spectral reflectance and transmittance as a function of angle of incidence and wavelength in the 0.83 to 2.5 μ region is described. Geometrical arrangement of sample, entrance port, and detector as well as directional characteristics of detector and sphere wall coating permit absolute or relative measurements to be made for a sample with an arbitrary reflection-distribution function.

REFLECTION OF PLANE WAVES BY RANDOM CYLINDRICAL SURFACES. See Abstr. 16561

16054 SOME ASPECTS OF OPTICAL LENS PERFORMANCE. I. SECONDARY FLARE IN LENSES.
K.Hacking.
BBC Engng. Monogr. (GB), No. 36, 5-14 (April, 1961).

The image formed by a lens is often reduced in contrast by extraneous light spread extensively over the image plane as a result of specular interfacial reflections within the lens and scattering by surface irregularities. A method of measuring the magnitude of the flare light is described. The theoretical relationship between the transmission factor of the lens and the flare component due to specular reflections is discussed. The non-uniform distribution of flare was investigated experimentally and the importance of lens cleanliness was demonstrated. The average results of flare measurements on a number of lenses used in television applications are given.

16055 SOME ASPECTS OF OPTICAL LENS PERFORMANCE. II. THE DESIGN OF LENS HOODS. W.N.Sproson.
BBC Engng Monogr. (GB), No. 36, 15-19 (April, 1961).

The factors which control the performance of a lens hood are discussed. A distinction is made between two degrees of protection given against unwanted light sources. Some numerical results are given which apply to the image orthicon television camera.

16056 A CONDITION FOR ACHROMATISM OF THREE LENSES. T.V.Pardhasaradhi.
Defence Sci. J. (India), Vol. 11, No. 2, 112-15 (April, 1961).

A system of three separated lenses is treated in terms of Hartmann constants. The solution of the general equation by making the Hartmann constants a_1, a_2 and a_3 equal to unity is naturally the simplest, and the condition of achromatism arrived at is shown to be that of three lenses in contact.

16057 THIN-LENS ABERRATION THEORY. C.G.Wynne.
Optica Acta (Internat.), Vol. 8, No. 3, 255-65 (July, 1961).

The general theory of the primary aberrations of thin lenses, including the primary aberrations of pupil imagery, is developed in a form adapted to its application to optical designing problems, and the methods of this application are discussed, with some examples.

16058 PHASE CHANGES AT THE FOCAL POINT. A.Rubinowicz.
Acta. phys. Polon. (Poland), Vol. 20, No. 4, 357-67 (1961).
In German.

The author has previously demonstrated that the phase change at a focal point arises purely from the use of geometric optics in defining the incident light waves. The present paper deduces the phase change by purely analytical methods and considers further its origin. R.W.Fish

16059 NEW CONCENTRIC SYSTEMS OF TWO GLASSES. G.Toraldo Di Francia and M.T.Zoli.
Atti. Fond. Ronchi (Italy), Vol. 16, No. 2, 148-57 (March-April, 1961).
In Italian.

The systems consist of an outer shell with refractive index n_1 and a core of lower refractive index. The spherical aberration was computed for an object at infinity and at six finite distances, with n_1 ranging from 1.5 to 4.0. These show that small spherical aberration can be obtained with n_1 greater than 2.0. A.R.Stokes

16060 TRIGONOMETRICAL VERIFICATION OF AN OPT SYSTEM BY ELECTRONIC COMPUTER. A.Kra
Atti Fond. Ronchi (Italy), Vol. 16, No. 3, 203-7 (May-June, 19
In Italian.

The usual optical equations for refraction at a spherical surface are put into an approximation form suitable for use w an electronic computer. They can then act as a simple check more exact calculations. R.V

16061 IMAGING OF SEPARATE LINEAR OBJECTS OF DIFFERENT WIDTH AND CONTRAST WITH SURF ING FIELD BY A COMBINATION OF AN OPTICAL SYSTEM A GRANULAR LAYER. L.P.Moroz.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 249-56 (Feb., 1961
In Russian.

Equations are obtained which enable the problem of findin required (threshold) values for the parameters which charact the optical system of the instrument, the granular layer (imag receiver), and the object, and also the problem of compensati changes in one group of parameters by changes in another gro parameters to be solved. A method is proposed to characteri quality of instruments which operate on the basis of optical in [English translation in: Optics and Spectrosc. (USA), Vol. 10, 124-7 (Feb., 1961)].

16062 OPTICAL ALIGNMENT DEVICES BASED ON A T MIRROR SYSTEM. J.Dyson.
Optica Acta (Internat.), Vol. 8, No. 3, 217-31 (July, 1961).

The requirements to be satisfied by an optical alignment are indicated, and a two-mirror system is described. The el ary form of this is restricted in its field of application, but it converted into a very sensitive interferometer for toolroom o laboratory use. Its errors and coherence conditions are exan Modifications of the simple system suitable for more practic conditions are described, and their errors are investigated. shown that very high accuracies can be obtained without exce demands on the optical workmanship. The effects of atmosph irregularities are indicated, and test results are described b

16063 INFLUENCE OF THE NUMBER OF GRATING LIN ON THE PRECISION OF TRANSMISSION FACTOR MEASUREMENTS. P.Lacomme.
Optica Acta (Internat.), Vol. 7, No. 4, 331-40 (Oct., 1960). In

In measuring optical performance in terms of transmissi factors, the number of lines in the grating can influence the r The theory is derived and means of reducing errors are exam R.

16064 REFRACTURE INDEX MEASUREMENT IN THE INFRARED. J.Vincent-Geisse and J.Lecomte.
J. Phys. Radium (France), Vol. 21, No. 11, 794-800 (Nov., 19
In French.

The interest of the measurements in different field is su and methods used, particularly the newer ones, are described bibliography of recent work is included.

16065 INVESTIGATION OF THE OPTICAL PROPERTIE TRANSPARENT MATERIALS AT ULTRA-HIGH PRESSURES.
Ya.B.Zel'dovich, S.B.Kormer, M.V.Sinitsyn and K.B.Yushko.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 6, 1333-6 (June 21, 196
In Russian.

By observing the reflection of a light beam on the front o shock wave as it passed through a transparent material it was possible to determine the refractive index of the material. M ments were made by recording the time of reflection at certa points in the apparatus with a photo-chronogram. Measureme were made on water, Plexiglas (Perspex) and glass. In the fi these the variation of refractive index with density was exami and compared with previous results. [English translation in: Soviet Physics—Doklady (USA)]. K.N.R.

16066 SYSTEMATIC OPERATIONAL TESTING OF THE VON ELLER OPTICAL SYNTHESIS MACHINE. J.C.Coppola.
J. sci. Instrum. (GB), Vol. 38, No. 10, 404-5 (Oct., 1961).

The machine gives the photographic sum of a large numb terms of a Fourier series. Several critically located compon on the instrument can easily get out of adjustment, simply thr normal use. A procedure is described for taking three photo-

ng to define that part of the instrument in need of adjustment
d amount of correction necessary.

1 57 MEASUREMENT OF THE CONTRAST TRANSMISSION OF MICROSCOPIC OBJECTIVES UNDER SERVICE
)N TIONS. H.Thiry.
al oc. Roy. Sci. Liege (Belgium), Vol. 30, No. 5-6, 300-9
)6 In French.
ne contrast transmission function of microscopic objectives
d rmined from the measure of the contrast in interference
tt as given by a Lloyd's mirror. The measurement of the modulus of
e ction involves several photographs of the fringes and
ic densitometer scannings. The transmission of frequencies
h n as 3000 mm^{-1} is easily determined. The phase angle of
e ction is measured by scanning sinusoidal signals with the
st objective and then without any objective.

IPROVED POWER SUPPLY FOR HIGH-TEMPERATURE
IC)SCOPY HOT STAGE DEVICE. See Abstr. 16213

68 APPLICATIONS OF INTERFERENCE MICROSCOPY.
R.Barer.
t > (GB), Vol. 190, 315-16 (April 22, 1961).
ummary of the proceedings of a Symposium held by the
)y Microscopical Society on March 15, 1961. R.Barer (Oxford)
r ved the principles and techniques of interference microscopy,
F .Ross (Leyden) described its use for measuring the solid
n nt of cell inclusions and E.J.Ambrose (London) described work
l division. Three papers dealt with non-biological appli-
t s: on crystal growth from solution (S.Goldsztaub, Strasbourg),
x fibres (R.C.Faust, Northwich) and automatic documentation
cro-film (M.Locquin, Paris). V.E.Cosslett

069 TWO-MIRROR SYSTEM WITH 140° FIELD.
J.M.Waldram.
Opt. (France), Vol. 39, No. 1, 24-6 (Jan., 1960).
lescribes a low-definition system for transmitting an image
inaccessible enclosure to a television camera. The centre
mirror is left un-silvered and the back in this region has a
ture which makes it function as a negative lens forming an
of the centre of the field at the same position and magnifica-
s the main system; thus there is no gap in the centre of the
due to central obstruction. W.T.Welford

3070 EXTREME ULTRAVIOLET REFLECTANCE OF LiF-COATED ALUMINUM MIRRORS.
Angel, W.R.Hunter, R.Tousey and G.Hass.
t. Soc. Amer., Vol. 51, No. 8, 913-14 (Aug., 1961).
The cut-off beginning at 1200 A for reflectance-increasing
ngs of MgF_2 on Al mirrors may be extended to 1000 A by re-
ng the MgF_2 by LiF. For a 170 A thick coating of LiF, the
tance is superior to a 250 A thick MgF_2 layer for wavelengths
er than 1125 A, reaching a maximum value of 60% at 1025 A.
A thick LiF coating is superior to MgF_2 for wavelengths
er than 1175 A, having a reflectance of 70% out to 1100 A but
g almost to the MgF_2 value at 1025 A. The coatings showed
ageing under normal laboratory conditions but deteriorated
the humidity rose above 50%. This deterioration could be
ded with little effect on performance by putting a further 15 A
of MgF_2 on the LiF N.Murcott

3071 A NEW PHASE FLUOROMETER.
H.G.Kloss and G.Wendel.
turforsch. (Germany), Vol. 16a, No. 1, 61-6 (Jan., 1961).
rman.
A cathode-ray beam of 10^{-8} to 10^{-6} A at 60 kV leaves a tube by
window 7 μ thick and excites a phosphor on the outside of the
ow. After a few stages of amplification in the photomultiplier
uorescence signal is combined with another signal modulated
frequency difference of 5 kc/s from the modulation frequency
e cathode-ray beam (33 Mc/s). Amplification of the fluorescence
l continues at the difference frequency, and the decay times are
ed from measurements of the phase angle between excitation
mission. An accuracy of $< 10\%$ is obtained for times between
10^{-10} and 2×10^{-8} sec, while the smallest interval measured is
10^{-11} sec. Air at atmospheric pressure is used as a reference
dard (decay time 6×10^{-10} sec). Some results are shown for
ecrease of decay time of organic phosphor crystals when
liated by electrons. S.T.Henderson

16072 SPECTROTURBIDIMETRY OF EMULSIONS.
J.D.S.Goulden.
Brit. J. appl. Phys., Vol. 12, No. 9, 456-60 (Sept., 1961).
A theoretical treatment of the turbidity of monodisperse emulsions is discussed and its application to polydisperse systems indicated. Modifications required to commercial spectrophotometers for carrying out spectroturbidimetric studies are described. The determination of both mean globule size and concentration of the suspended phase in homogenized emulsions is illustrated.

16073 LINE BROADENING BY AN AMPLITUDE SELECTOR.
P.Moatti.
J. Phys. Radium (France), Vol. 22, No. 4, 225-9 (April, 1961).
In French.
The broadening of an energy spectrum by summation in the channels of an amplitude selector. The case is specified of the distortion of a Gaussian curve built with rectangular steps. The parameters of the original curve are deduced from the experimental one. This method is applied to the study of fluctuations in photomultiplier gain.

16074 MATHEMATICAL FILTRATION IN SPECTROSCOPY BY FOURIER TRANSFORMATION. J.Connes and V.Nozal.
J. Phys. Radium (France), Vol. 22, No. 6, 359-66 (June, 1961).
In French.
To obtain the maximum signal to noise ratio in transforming an interferogram into a spectrum the number of points that have to be measured is much greater that the number of spectral elements; hence the time spent in calculation is excessive. With the method of "mathematical filtration" the convolution of the interferogram registered by the impulse response of an ideal filter is found, isolating the wanted domain of Fourier frequencies. Then the Fourier transform of the new interferogram is computed with a smaller number of points; the time spent is thus much reduced.

16075 VIBRATION–ROTATION STRUCTURE IN ABSORPTION BANDS FOR THE CALIBRATION OF SPECTROMETERS FROM 2 TO 16 MICRONS.
E.K.Plyler, A.Danti, L.R.Blaine and E.D.Tidwell.
Nat. Bur. Stand. (USA), Monogr. No. 16, 20 pp. (1960).
Suitable bands of common gases are tabulated and were remeasured wherever necessary from 2 to 16 μ to obtain an accuracy of about 0.03 cm^{-1} throughout the region and to provide good calibrating points at frequent intervals. Some 600 rotation–vibration lines are illustrated in 20 spectrograms and wave-numbers are listed in tables with considerable intercomparison with worthy data obtained in other laboratories. The absorption bands were remeasured or calibrated by using either a precisely graduated grating circle or standard atomic lines with the fringe system formed by a Fabry–Perot interferometer. Characteristic features of the individual bands are discussed briefly and references to other publications are given. The substances used for calibration include H_2O, CO_2, CO, HCl, HBr, NH_3, C_2H_2, CH_4, N_2O, and polystyrene film.

16076 STUDY OF A CALIBRATION SYSTEM FOR VIBRATION–ROTATION SPECTRA IN THE NEAR INFRARED.
C.Haeusler, Y.Cornet and P.Barchewitz.
J. Phys. Radium (France), Vol. 21, No. 12, 809-18 (Dec., 1960).
In French.
The principle of the calibration method consists in recording simultaneously the absorption spectrum and interference peaks which allows localization of the absorption lines relative to standard lines. The interference peaks are produced by a Perot–Fabry etalon whose fringes at infinity are projected on the entrance slit of the spectrograph. The precision attained is 0.01 cm^{-1}.

16077 SPECTROSCOPY OF EXTREME INFRA-RED WAVE-LENGTHS.
D.Bloor, T.J.Dean, G.O.Jones, D.H.Martin, P.A.Mawer and C.H.Perry.
Proc. Roy. Soc. A (GB), Vol. 260, 510-22 (March 21, 1961).
Improved spectroscopic techniques are described for the difficult and relatively unexplored region of the extreme infra-red (between 70 μ and 1 mm wavelength), in which good sources of radiation do not exist. The improvements include the development and application of a superconducting bolometer, whose detectivity is about 100 times superior to that of the best room-temperature detector sensitive at these wavelengths.

16078 MOLECULAR EMISSION SPECTROSCOPY FROM 2 μ TO 12 μ BY A MICHELSON INTERFEROMETER.
H.A.Gebbie, G.Roland and L.Delbouille.
Nature (GB), Vol. 191, 264-5 (July 15, 1961).

A combination of an interferometer and Fourier transformation using an electronic computer is very suitable for measuring low-intensity spectra. Using gas in a slightly heated cell with rocksalt windows, a light chopper, an interferometer with a barium fluoride plate and special system for measuring the mirror movement, and the Ace computer, large-dispersion emission spectra of vibration—rotation bands of NH_3 at 70° C are obtained. A.G.Gaydon

16079 CRITICAL STUDY OF THE PRINCIPAL METHODS OF ILLUMINATION OF SPECTROGRAPHS. P.Boillet.
Rev. Opt. (France), Vol. 39, No. 2, 47-63 (Feb.); No. 4, 147-66 (April, 1960). In French.

Expressions are developed and discussed for the flux from a spectrograph in terms of the intensity per unit volume of source. Cases considered are (1) direct illumination of the slit without a condenser lens (2) use of a condenser lens and (3) use of 2 lenses. The paper discusses photographic methods where the flux at a single point of the image is relevant and the use of a photocell where the flux from the whole slit length is important. Illumination conditions for measurements of source intensities and of reflection, transmission and scatter (Raman spectra) are considered.
G.F.Lothian

16080 STUDY OF THE 9 METRE SPECTROGRAPH OF THE PARIS—MEUDON OBSERVATORY. M.Le Ray.
Ann. Astrophys. (France), Vol. 23, No. 6, 986-94 (1961). In French.

The grating efficiency for different orders and wavelengths, the instrumental profile and ghost intensities in the fifth order were measured photoelectrically.

16081 THE RAPID MEASUREMENT OF SPECTRAL INTENSITY WITH AN OSCILLATING FABRY—PEROT SPECTROMETER: ISOTOPE ABUNDANCE IN MERCURY.
D.J.Bradley.
Proc. Roy. Soc. A (GB), Vol. 262, 529-40 (Aug.8, 1961).

A high-resolution photoelectric spectrometer employing a mechanically scanned Fabry—Perot interferometer is described. The spectrometer produces high-finesse spectral profiles continuously and rapidly at repetitive frequencies of up to 1000 c/s corresponding to a time resolving limit of 4 μsec for a scan of 5 orders. The display is on an oscilloscope or a pen-recorder function-plotter. The instrument was tested with the high-frequency discharge spectrum of mercury. Single intensity measurements are reproducible to better than 0.5%. The wavelength scale is linear to 0.5% over an order and can be corrected to four times this accuracy. Hyperfine structures agree well with recent determinations which use both pressure scanned and photographic Fabry—Perot systems. The mercury isotope abundances were obtained from the spectral intensity measurements agreeing well with mass-spectrometer values. The r.m.s. deviation for a single determination is less than 0.5% of the percentage abundance. Possible applications to rapidly varying phenomena in gas discharges and shock waves, the determination of refractive indices and extension to the ultraviolet region for spectroscopy from an earth satellite are briefly considered.

16082 A VACUUM MONOCHROMATOR FOR FAR ULTRA-VIOLET. J.Romand and B.Vodar.
Rev. Opt. (France), Vol. 39, No. 4, 167-74 (April, 1960). In French.

Gives a brief description of a vacuum ultraviolet normal-incidence grating monchromator. The focusing device provides a linear wavelength scale and the resolution is better than 0.5 A in the spectral range of the apparatus, which extends from 500 to 3000 A.

16083 NOTE ON THE TEMPERATURE DETERMINATION OF THE IRON ARC AND THE DERIVATION OF F VALUES.
V.Letfus.
J. Opt. Soc. Amer., Vol. 51, No. 10, 1151 (Oct., 1961).

A criticism of the method used by Hefferlin (Abstr. 7935, 12001 of 1959) to determine the temperature of the d.c. iron arc and derive f values. An alternative approach, using a theoretical expression for the curve of growth of emission lines, gives the arc temperature as 4900° K (Hefferlins' value was 4300° K). A ° correction formula to be applied to Hefferlins' f values is given. For most lines the correction is less than the accuracy of the original value determinations. P.M.Reynolds

16084 BRIGHTNESS TEMPERATURES AND INTENSIT MEASUREMENTS IN FLASH DISCHARGES.
W.H.Parkinson and E.M.Reeves.
Proc. Roy. Soc. A (GB), Vol. 36, 409-19 (July 18, 1961).

The brightness temperature and the intensity distributi the Lyman, coaxial and capillary-type flash tubes were mea and compared over the wavelength range from 2580 to 4520 brightness temperature, obtained by comparison with a stan lamp, for these flash tubes ranged from 13 000 to 30 000° K. intensity per unit wave-number was found to be independent number over the above range for the Lyman and coaxial tub the capillary flash the region independent of wave-number e up to 31 000 cm^{-1} beyond which the continuum decreased ex in agreement with the predictions of the Unsöld—Kramers t

16085 DETERMINATION OF THE WAVELENGTH OF $2p_{10}$-$5d_5$ LINE OF Kr^{86} FOR NON-PERTURBED
E.Engelhard and J.Terrien.
Rev. Opt. (France), Vol. 39, No. 1, 11-18 (Jan., 1960). In F

Extrapolations from measurements on Kr^{86} lamps at va pressure and temperature were used to obtain the wave-nur unperturbed atoms as a function of temperature correct to in 10°. The wave-number is given as 1650763.73 ± 0.004 m pressure and 56° K. W.T

16086 SPECTRAL LINES OF NARROW BREADTH.
M.Bottema.
Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 6, 18 (June, 1960). In Dutch.

A survey of recent work on the production of fine spect lines using discharge lamps containing pure isotopes. Part mention is made of the work at the National Bureau of Stand that of Gardner and Nefflen (Abstr. 3644 of 1960). The leas quoted (the breadth at half the height) is 0.003 cm^{-1} found fo by an atomic beam method and for Hg^{198} by the use of a sphe interference filter.

16087 SCHULER SPECTRAL LAMPS FOR HYPERFIN STRUCTURES. V.Tatu.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 4, 521-59 (1958 In Roumanian.

16088 A CONTRIBUTION TO A STUDY OF LIGHT SOU FOR THE FAR ULTRAVIOLET AND THEIR AP TION TO SPECTROCHEMICAL ANALYSIS. G.Balloffet.
Ann. Phys. (France), Vol. 5, No. 9-10, 1243-1300 (Sept.-Oct In French.

A new type of vacuum spark discharge was developed fo analysis of spectra in the far u.v. between 2000 A and 500 A spectra were analysed for using various values of the spark meters and a number of lines of highly ionized atoms of var elements were identified. Some of the lines were classified "raies ultimes" according to the authors' definition. A deta study was made of the variation of the intensity with concen of the element introduced into the spark. The elements exa were: C, O, Na, F, Si, P, S, Cl, Ge, As, Se, Br, Sn, Sb, Te, excitation temperature was determined by using calculation Bates and Damgaard, and by measuring the intensity ratio o in the spectra of Al III, Si IV, and Cl VII. It was postulated state of thermal equilibrium was reached in the discharge. similarity of the temperatures for Al III and Cl VII seems t this assumption. W.

16089 AN EMISSION SOURCE OF CONTINUOUS SPEC EXTENDING FROM THE VISIBLE TO THE EXT ULTRAVIOLET. G.Balloffet, J.Romand and B.Vodar.
C.R. Acad. Sci. (France), Vol. 252, No. 26, 4139-41 (June 26 In French.

The source is a modified condensed spark in vacuum; three electrodes of heavy metal (e.g. uranium or platinum). maximum discharge current is of the order 50000 A, and the duration around 0·3 μsec. The continuum extends to at leas A.G.

16090 THE ELECTRIC FIELD IN A HOLLOW-CATHO DISCHARGE LAMP. H.Fontaine and J.Brochar
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 43A-47A (Feb., 1961). In French.

Measurements were made on forbidden line $2\,^1P - 4\,^1F$ helium. Determinations were made of ion density, which ch ises interionic field in the cathodic spot, and also of the dir

d the cathodic sheath. It is also shown that useful hollow-
h light always contains light coming from the sheath, which
i y to modify certain precision measurements.

PRODUCTION OF LIGHT PULSES OF NANOSECOND
1)1 RISE TIME AND DURATION BY MEANS OF GAS-
C ARGE TUBES. Z.Náray and P.Varga.
ic Instrum. (GB), Vol. 38, No. 9, 352-4 (Sept., 1961).
)rt light pulses of rise time 3×10^{-9} s can be produced by a
ic circuit arrangement containing commercially available gas-
c ge tubes (e.g. thyratron tubes type 2050, voltage-stabilizer
e ype VR150). These pulses are of sufficient intensity to be
p ed directly on cathode-ray tubes, using high-gain photo-
li iers, without the help of amplifiers.

FLASH LAMPS OPERATING BY EXPLOSION OF
1)2 METAL WIRES. J.Ripoche.
P s. Radium (France), Vol. 22, Suppl. No. 2, 48A-52A (Feb.,
3 In French.
the electrical circuit constructed, a coaxial shunt
= 0108Ω) is incorporated. It allows measurements of currents
b ade, and also of the inductance of electrical circuit
= 25 μH), with the oscillograms obtained. During the explosion
a inium and nichrome wires the intensity of the current was
a red in this manner. The light intensity was qualitatively
c l with a phototube.

LIGHT-TO-LIGHT DISCRIMINATOR SWITCH.
1)3 G.Palmieri and R.Sanna.
o Cimento Suppl. (Italy), Vol. 19, No. 1, 91 (1961).
ansducer yields calibrated light output when input is
n ated beyond a fixed threshold.

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

AN APPROXIMATE THEORY OF THE OPTICAL PARA-
)94 METERS OF ABSORBING CRYSTALS.
V oncharenko.
I llografiya (USSR), Vol. 4, No. 6, 849-54 (Nov.-Dec., 1959).
I sian.
variance methods are applied to consider the optical para-
s of crystals whose absorption and anisotropy are small;
n strongly absorbing crystals are also considered. Definitions
e ven of the meanings of the refraction and absorption ellipsoids
e n the Voigt–Drude theory; deductions are given for the
i ions under which those ellipsoids may be used to derive the
parameters of absorbing crystals. [English translation in:
Physics–Crystallography (USA), Vol. 4, No. 6, 807-11
1960)].

PREPARATION OF THIN FILMS VARYING LINEARLY
095 IN THICKNESS IN A GIVEN DIRECTION.
re and H.Damay.
/s. Radium (France), Vol. 22, No. 6, 138A-139A (June, 1961).
nch.
hin-film optical wedges were prepared by deposition in vacuum.
ration was carried out from a source inside a rotating
trical mask. With suitably shaped cut-outs in the cylindrical
coating of varying thickness was produced in one direction
a stationary glass substrate outside the mask. Some results
oted for a magnesium fluorite deposit showing a linear
ff in optical thickness. W.Steckelmacher

EXPERIMENTAL PROOF OF CALCULATIONS OF
096 MULTIPLE [OPTICAL] THIN FILM SYSTEMS.
aut and L.Villena.
eal Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 5-6, 285-92
-Dec., 1960). In Spanish.
spectral reflectance and transmittance were calculated for
us high-efficiency thin-film systems. Measurements obtained
films made by thermal evaporation show some discrepancies,
are said to be due to granularities in the film. Methods of
olling thickness of the films during evaporation are briefly
ssed. R.W.Fish

STUDY OF THE PERFORMANCE OF DIELECTRIC
16097 THIN FILM BEAM DIVIDING SYSTEMS.
L.A.Catalan and T.Putner.
Brit. J. appl. Phys., Vol. 12, No. 9, 499-502 (Sept., 1961).

A theoretical and practical study was made to compare the optical performances of single-layer $\lambda/4\,TiO_2$ and double-layer $\lambda/4\,MgF_2$-$\lambda/4\,TiO_2$ coatings when used as beam-dividing systems. Theoretical and experimental values of the spectral response for light arriving at normal incidence and at 45° incidence are given together with the values for reflectance as a function of angle of incidence for monochromatic light. The optical characteristics of glass--film–glass beam dividing systems are also investigated. It is further shown that the efficiency of a system consisting of a reflecting single $\lambda/4$ layer between glass boundaries is improved by the introduction of a second $\lambda/4$ low refractive index film layer.

TOLERANCES FOR LAYER THICKNESSES IN
16098 DIELECTRIC MULTILAYER COATINGS AND
INTERFERENCE FILTERS. K.D.Mielenz.
J. Res. Nat. Bur. Stand. (USA), Vol. 64A, No. 6, 487-96 (Nov.-Dec., 1960).

A theory is developed for dielectric multilayer coatings in which the layers depart from calculated thickness. The theory is applied to alternating systems of quarter wave layers of ZnS and MgF_2. The effects of thickness errors are: (1) A shift of the wavelength at which maximum reflectance occurs; and (2) a change in phase shift upon reflection. The magnitude of these effects, and also their dependence on various parameters, are determined. Statistical tolerances for layer thicknesses are computed for given tolerances on the multilayer performance. The accuracy required for producing dielectric interference filters is up to about 40 times higher than the accuracy sufficient for the production of dielectric mirrors and beam splitters. Various techniques of experimentally controlling film thicknesses, and their accuracies, are discussed. The production of mirrors and beam splitters deviating from theoretical maximum reflectance by only 1% seems to be possible with Dufour's simple single photocell method of monitoring film thicknesses. With more precise methods, such as those developed by Giacomo and Jacquinot, or Traub, the production of interference filters appears to be possible to within plus or minus one half their half widths.

THE OPTICAL PROPERTIES OF DIELECTRIC
16099 FILMS WITH SLIGHT DEPARTURES FROM
HOMOGENEITY. G.Koppelmann and K.Krebs.
Z. Phys. (German), Vol. 163, No. 5, 539-56 (1961). In German.

The reflectivity near the polarizing angle is calculated both for slightly non-homogeneous dielectric films (possessing a small gradient in the refractive index) and also for double layers having slightly differing refractive indices. Thus deviations can be removed which may arise when the refractive indices are determined from the Brewster angle, and it is also possible to work out a procedure for analysing the structure of the various layers from experimentally obtained spectral reflectivity curves near the Brewster angle.

OPTICAL INVESTIGATION OF THE STRUCTURE OF
16100 CRYOLITE EVAPORATED FILMS.
G.Koppelmann, K.Krebs and H.Leyendecker.
Z. Phys. (Germany), Vol. 163, No. 5, 557-70 (1961). In German.

Non-homogenities in the structure of cryolite films (produced by evaporation in vacuo) are analysed, applying the theory of Pt I on measurements of spectral reflectivity near the Brewster angle and with normal incidence. Some quantitative information is obtained about the variation of refractive index within the layers, in which the absorption of water molecules plays an important part.

AN EXACT DESIGN METHOD FOR MULTILAYER
16101 DIELECTRIC FILMS. R.J.Pegis.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1255-64 (Nov., 1961).

A review is made of the theory behind the calculation of reflectances of dielectric multilayer films whose component layers are of unit optical thickness. The equations for the boundary conditions are then cast in a form leading to the exact solution for refractive indices. A detailed sample calculation for a five-layer combination is included. For large numbers of layers automatic digital computation is recommended.

ON SOME DEGENERATE CASES OF THIN FILM
16102 INTERFERENCE. P.G.Kard and Z.Knittl.
Optica Acta (Internat.), Vol. 8, No. 3, 185-97 (July, 1961).

The theory of a metallic interference film is scrutinized in peculiar situations brought about by performing various mathema-

tical limiting processes on the refractive indices. Special attention is paid to geometric degeneration of the layer to a single boundary in such conditions. The relation of the discussion to some real layers is indicated.

16103 DOUBLE-PASSED TWO-BEAM INTERFEROMETERS. II. EFFECTS OF SPECIMEN ABSORPTION AND FINITE PATH DIFFERENCE. P.Hariharan and D.Sen.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1212-18 (Nov., 1961).

For Pt I, see Abstr. 5173 of 1960. Expressions are obtained for the irradiance distribution in the fringe systems in double-passed Jamin and Twyman–Green interferometers with an absorbing specimen in one of the paths. Expressions are also obtained in the latter case for the effects of the spectral coherence of the source, the degree of collimation of the incident beam, and the wedge angle of the virtual air film in which interference takes place, on the irradiance distribution in the fringe pattern obtained with an appreciable optical path difference. The theoretical loss in setting accuracy in the various cases, as well as the corrections to be applied to obtain the true optical path difference, are evaluated.

16104 INFLUENCE OF LIGHT SOURCE SIZE ON INTERFERENCE IN GEOMETRICAL SHADOW.
B.Marković and D.Miller.
Period. math.-phys. astron. (Yugoslavia), Vol. 15, No. 2, 135-41 (1960).

A study is made of the interference patterns associated with a type of Fresnel fringes and the edge diffraction fringes. The influence of the size of the light source is examined experimentally. The corresponding Lloyds' mirror fringes are also examined. The effect of broadening the light source is shown photometrically on fringe visibility. S.Tolansky

16105 NOTES ON THE LUSTRE OF MOIRÉ PATTERNS.
J.Nishiwaki.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1358-60 (July, 1961).

Moiré patterns produced by passing diffuse light from uniformly illuminated background through two net or gauze screens of suitable mesh size, set face-parallel, one behind the other with a space in between, were tinged with some lustre which is more or less vitreous or slightly metallic. A number of results obtained by visual observation and photography show that this is a typical case in which the so-called false stereoscopic effect gives rise to the impression of gloss.

16106 ON APPROXIMATE ELECTROMAGNETIC THEORIES OF DIFFRACTION. I. B.Karczewski.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 403-9 (1961).

Derives effective formulae for the electromagnetic field in the case of Fraunhofer diffraction within the framework of Kottler (Abstr. 2398 of 1923), Severin [Z. Naturforsch. (Germany), Vol. 1, 487 (1946)] and Vasseur (Abstr. 981 of 1953) theories. The properties of an arbitrary plane diffracting screen are shown to have no effect on the distribution of the electromagnetic field energy density near the centre of the diffraction image. It is suggested that measurements should be carried out to decide which of the three theories yields results in best agreement with experiment.

16107 FRESNEL DIFFRACTION BY ABSORPTIVE WEDGES. T.Kitahara.
J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 597-617 (Dec., 1960).

The results of calculation showed that, when the absorptivity of the wedge was appreciable, a highly visible fringe appeared on the material side of the edge in the real image. The origin of the highly visible fringe was discussed in terms of curves, similar to Cornu's spiral, which were derived from the two integrals:

$$\int_{-\infty}^{u_s} [\exp \kappa p(u - u_s)] \cos(\pi u^2/2)du$$

$$\int_{-\infty}^{u_s} [\exp \kappa p(u - u_s)] \sin(\pi u^2/2)du,$$

where κ is the absorption coefficient of the wedge, and p, a positive parameter. The results were compared with the diffraction fringes observed in electron microscope images near focus. The fact that the feature of this highly visible fringe predicted by the calcu agreed satisfactorily with the observed feature in shape and ance was noted.

16108 ENERGY DISTRIBUTION IN THE DIFFRACTION LIGHT OF ARBITRARY BEAM WIDTH BY UNDAMPED AND DAMPED ULTRASONIC WAVES. E.S.Rajago
J. Sci. industr. Res. (India), Vol. 20B, No. 5, 189-93 (May, 19

Many workers have used the specific intensity of radiati the theoretical explanation of the diffraction of light by ultras waves, while experimentally only the total energy associated the diffracted beams is measured. In this paper the expressi for the total light flux in any order are first derived on the si Raman–Nath theory. The interesting cases (1) the width of t light beam not large compared to the sound wavelength and (2 obliquity factor, are pointed out. The theory is then develope attenuated sound waves. The intensities show a flattening (sh maxima and minima) compared to the usual J_n^2–v_0 curves and not become zero even when v_0 becomes a zero of the corresp Bessel function. The effect of the present calculations on the usual absorption measurements is shown to be negligible. Th theory is valid for frequencies less than ~10 Mc/s and the u experimental frequencies are not sufficiently low.

16109 ON THE DIFFRACTION OF LIGHT BY STANDIN SUPERSONIC WAVES: OBLIQUE INCIDENCE O THE LIGHT. F.Kuliasko and R.Mertens.
Simon Stevin (Netherlands), Vol. 34, No. 3, 126-36 (Feb., 19

A system of difference-differential equations describing diffraction of light by standing supersonic waves in the case oblique incidence is obtained. Expressions are found in firs approximation for the intensities of the first-order diffracti lines, which are asymmetric with respect to the zero order, result in accordance with the general theory. These expres however, do not remain valid when the angle of incidence of light is in the immediate neighbourhood of the Bragg angle, the intensities of the orders + 1 and - 1 are then no longer quantities of the same order of greatness. In this case the calculation of the intensities of the orders 0, and +1, and aft wards of those of the orders - 1 and + 2 is done by a differe method, due to Phariseau. Finally the general solution of th system of difference-differential equations in the form of a of Bessel functions is established. The well-known results ing the coherence of the spectra of even and odd orders, fou the case of normal incidence, also hold in the case of obliqu incidence of the light.

16110 STREHL INTENSITY [DEFINITIONSHELLIGKEIT CONTRAST TRANSFER. F.I.Havlíček.
Optica Acta (Internat.), Vol. 8, No. 3, 213-15 (July, 1961). In German.

An approximate formula for the light intensity in the Ai pattern is suggested and used to calculate contrast transfer function of Strehl intensity and spatial frequency. W.T.

16111 MULTIPLE RAYLEIGH SCATTERING. N.Ryu.
Mem. Fac. Engng Hiroshima Univ. (Japan), Vol. 1, No. 3, 185-9 (Feb., 1960).

A transport equation is used to derive a formula for mu Rayleigh scattering at small angles. D.J.T

16112 SUPPLEMENTARY NOTE TO THE PAPER: MOLECULAR THEORY OF LIGHT SCATTERING MULTICOMPONENT SYSTEMS. S.Kielich.
Acta phys. Polon. (Poland), Vol. 20, No. 1, 83-8 (1961).

This note develops general expressions for factors F wh appear in an equation given in the paper mentioned (Abstr. 2 of 1961) for the intensity scattered at angle θ. F has compon which "characterize the molecular mechanism of isotropic a anisotropic light scattering", for a system including "quadru anisotropically polarizable and hyperpolarizable molecules". G.F.

16113 SCATTERING FROM A PENETRABLE SPHERE SHORT WAVELENGTHS. S.I.Rubinow.
Ann. Phys. (USA), Vol. 14, No. 1, 305-32 (July, 1961).

A scalar plane wave incident on a penetrable sphere is considered in the short wavelength limit. A new representat of the scattering amplitude is introduced which is particularl appropriate in this limit, and which requires only the evaluat certain integrals. Some of these may be evaluated asymptoti by the method of steepest descent and lead to the geometrica

field contribution. Included in this is the bow field. The der of the integrals are evaluated by the method of residues d to the diffracted field contribution. This "diffracted ray" s known from recent investigations in diffraction theory. ential part of the analysis is the introduction of the para- p, the number of internal refractions that a ray which hits ere undergoes. The results obtained are all in agreement at which would be expected on the basis of geometrical tion theory.

14 MEASUREMENT OF THE SCATTERING PROPERTIES OF HYDROSOLS. J.E.Tyler.
Soc. Amer., Vol. 51, No. 11, 1289-93 (Nov., 1961).
e scattering properties of prepared stable hydrosols were d by two independent methods, by integration of volume- ing function data, and by direct measurement of the total ing. The correlation coefficient between the two methods was Data are given for the total attenuation coefficient, the total- ing coefficient, the forward- and backward-scattering coeffi- and the volume-scattering function for two samples of water e prepared hydrosol consisting of 40 cc of skim milk in llons of water. For the prepared hydrosols a correlation ient of 0.999 was found between the total scattering coefficient e volume-scattering function at 45°. A comparison is made n the present data for distilled water and data published by t in 1945.

15 SOME CONTRIBUTIONS TO THE THEORY OF LIGHT SCATTERING BY SYSTEMS OF PARTICLES.
anu and E.Toma.
Cercetari Fiz. (Roumania), Vol. 10, No. 4, 825-36 (1959).
manian.
y applying the integro—differential method, the intensity of cattered by small systems of particles in the second approxi- is calculated. For systems formed of dielectric spheres, in comparison with the wavelength, situated on a circular area, it is shown that the second approximation as well as the ne tend to increase the scattering in the forward direction and attenuate the dependency of the scattered light on the wave- .

116 THE SENSITIVITY OF POLY-DISPERSIVE INDICATRICES TO THE FORM OF DISTRIBUTION CURVES.
ifrin and V.F.Raskin.
Akad. Nauk SSSR, Vol. 137, No. 1, 64-7 (March 1, 1961).
ssian.
he indicatrix $I(\beta)$ of light dispersion in a colloidal system is by

$$I(\beta) = \int_0^\infty I(\beta, a) f(a) da$$

$I(\beta,a)$ is the indicatrix for a separate particle of radius a, the distribution curve and β is the angle of dispersion. The acy with which f(a) can be determined depends on the range gnitudes of the roots of the algebraic system of equations to solve the above Fredholm integral equation for a given ete set of values of $I(\beta,a)$. Taking particular examples for f(a), uthor shows that the rate of change $dI/d\beta$, and the value of or small angles, also radically influence the sensitivity of a on. [English translation in: Soviet Physics—Doklady (USA), 6, No. 3, 228-30 (Sept., 1961)]. J.K.Skwirzynski

117 APPLICATION OF THE METHOD OF SPHERICAL HARMONICS TO THE STUDY OF THE STATE OF RIZATION OF SCATTERED RADIATION. J.Lenoble.
Acad. Sci. (France), Vol. 252, No. 23, 3562-4 (June 5, 1961).
ench.
The scattering in a diffusing medium may be obtained by the od of Kušćer and Ribarić (Abstr. 3306 of 1959).
A.R.Stokes

118 THE BOUNDARY CONDITIONS FOR ELECTROMAGNETIC WAVES AT THE SURFACES OF OPTICALLY VE CRYSTALS. Yu.A.Tsvirko and M.A.Tolnazina.
tverdogo Tela (USSR), Vol. 3, No. 5, 1393-9 (May, 1961).
ssian.
An additional boundary condition is obtained for electromagnetic s at the surface of an optically active crystal. The trans- ion of electromagnetic waves through a plane-parallel slab nsidered for a uniaxial crystal with propagation along the For optical frequencies close to the exciton absorption frequency, another special direction arises at right angles to the optic axis. The transmitted intensity shows an oscillatory dependence on slab thickness. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1011-15 (Nov., 1961)]. I.D.C.Gurney

16119 THE MAGNITUDE AND SIGN OF THE PHASE DIFFERENCE $\Delta = \delta_p - \delta_s$. I.N.Shklyarevskii, N.A.Vlasenko, V.K.Miloslavskii and N.A.Nosulenko.
Optika i Spektrosk. (USSR), Vol. 9, No. 5, 640-3 (Nov., 1960).
In Russian.
Describes polarization and interference methods of determining the magnitude and sign of the phase difference $\Delta = \delta_p - \delta_s$, which occurs in polarization measurements of the optical constants of metals (δ_p and δ_s are, respectively, the phase shifts of the p- and s-components of the electric vector on reflection by a metal surface). [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 5, 337-9 (Nov., 1960)]. A.Tybulewicz

16120 EXTENSION OF FRESNEL'S FORMULA TO THE CASE OF ABSORBING UNIAXIAL CRYSTALS. H.V.Skrots'kyĭ and H.H.Taluts.
Ukrayin fiz. Zh. (USSR), Vol. 4, No. 6, 724-8 (1959). In Ukrainian.
Formulae are obtained for the coefficient of reflection and phase jump on reflecting light from a uniaxial crystal having an optical axis perpendicular to the reflecting surface. Special cases of intensely and weakly absorbing crystals are investigated, and a study is made of crystals with pronounced anisotropy of absorption.

16121 INFLUENCE OF UNIDIRECTIONAL DEFORMATION OF CUBIC CRYSTALS ON THE QUADRUPOLE EXTINCTION ABSORPTION OF LIGHT. V.I.Cherepanov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1493-1500 (May, 1961).
In Russian.
It is shown theoretically that when a cubic crystal belonging to class O_h is compressed along a four-fold symmetry axis, a quadrupole extinction line of one particular type is split into two components, whereas if the stress is applied along a two-fold axis, the line is split into three components. The intensities and polarizations of the components are given. The theoretical findings are supported by the experiments of Gross and Kaplyanskii on Cu_2O (Abstr. 3829 of 1961). [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1082-7 (Nov., 1961)]. R.F.S.Hearmon

16122 OPTICAL ROTATORY DISPERSION OF CRYSTALS. S.Chandrasekhar.
Proc. Roy. Soc. A (GB), Vol. 259, 531-53 (Jan. 24, 1961).
Many formulae have been proposed to express the rapid increase of the rotatory power of quartz with diminishing wavelength. These consist mainly of terms of the Drude type, namely

$$\rho = \sum_r \frac{Q_r}{\lambda^2 - \lambda_r^2}$$

and require a large number of constants to fit the measurements in the u.v. region of the spectrum. It is shown in this paper that the entire range of data from the visible to the remote u.v. is accurately represented by the following simple formula

$$\rho = \frac{k\lambda^2}{(\lambda^2 - \lambda_0^2)^2}$$

where $k = 7.19$, and $\lambda_0 = 0.0926283\mu$. A theoretical interpretation of the formula is given on the basis of a coupled oscillator model. It is suggested that the rotatory power of quartz arises primarily as a result of an interaction in the nature of a resonance between the similar polarizable units constituting the crystal. This type of interaction causes a splitting of the characteristic frequencies of each individual unit, and the expression for the rotatory power is consequently of the quadratic form. Formulae are also given for sodium chlorate, cinnabar and benzil, all of which, like quartz, are optically active only in the crystalline state. The applicability of the quadratic formula to these cases is discussed.

16123 ON THE NOTION OF EMISSION ANISOTROPY. A.Jabłoński.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 4, 259-64 (1960).
Emission anisotropy is used, as a simpler parameter than degree of polarization or depolarization, to discuss theoretical expressions involving polarization of photoluminescence. The effects on luminescence decay are considered. J.B.Birks

COLORIMETRY . PHOTOGRAPHY

16124 THE MAXWELL COLOUR CENTENARY. W.D.Wright.
Nature (GB), Vol. 191, 10-11 (July 1, 1961).

A report of a conference held in London on 16-18 May 1961 under the joint auspices of the colour group (GB) and the Inter-Society Color Council (USA) and attended by about 220 members from twelve countries.

16125 THE QUANTUM SENSITIVITY OF PHOTOGRAPHIC EMULSION GRAINS. G.C.Farnell and J.B.Chanter.
J. photogr. Sci. (GB), Vol. 9, No. 2, 73-92 (March-April, 1961).

A method is described of obtaining the response curves of individual size classes of a photographic emulsion in which the exposure scale is expressed in absorbed quanta per grain. No assumptions of any significance are involved. The method is applied to the derivation of sensitivity characteristics of grains in modern emulsions of high speed for their average grain size, and to other emulsions not chemically-sensitized to such a high level. It is found that the sensitivity spread among grains of a single size may vary from about 1.0 to 2.0 log units, depending on the emulsion, but does not vary greatly for grains of different size in the same emulsion. The numbers of absorbed quanta involved are such that the greater part of this spread must be attributed to the fact that, within a single size class, grains differ widely in the numbers of quanta which they must absorb in order to be rendered developable; quantum fluctuations make only a small contribution to the spread in exposures over which grains become developable. Grains of the highest sensitivity encountered become developable after absorption of about four quanta, which suggests that a latent image of minimum developable size consists of four silver atoms.

16126 HOW MANY QUANTA? A.Marriage.
J. photogr. Sci. (GB), Vol. 9, No. 2, 93-105 (March-April, 1961).

The technique of residual grain size analysis gives for each size-class of grains in an emulsion the proportion of grains developed, as a function of the exposure expressed as the average number of quanta absorbed. A method has been found for disentangling the effect of random quantum fluctuations, to find the proportion of grains which, under the given conditions, were rendered developable by the various integral numbers of quanta. The three curves so far analysed suggest that three or four is the minimum number of quanta required for developability.

16127 ACCELERATING ACTION OF SOUND ON THE DEVELOPMENT OF A PHOTOGRAPHIC EMULSION. M.E.Arkhangel'skii.
Akust. Zh. (USSR), Vol. 6, No. 2, 180-6 (1960). In Russian.

An evaluation is made of the effect of an acoustic wind and of the heating of the backing of a photographic material on the image darkening density in the sonography of a cross-section of the field from a 3 Mc/s radiator. It is established that in sonography the law of interchangeability holds for the values of the acoustic pressure and development time. It is shown that the effect of sound on the development process is connected with the effect of the latter on the adsorption of the developer by the developing centres. [English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 2, 178-84 (Oct.-Dec., 1960)].

THE DEVELOPMENT OF NUCLEAR EMULSION STACKS.
See Abstr. 13256

16128 INFORMATION CAPACITY OF PHOTOGRAPHIC FILMS. R.C.Jones.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1159-71 (Nov., 1961).

The information capacity of four Kodak films is computed. The results lie in the range from one to six million bits per cm^2 — Panatomic-X film having the largest information capacity, and Royal-X film the least. The basic formula for the information capacity of a photographic film involves the Wiener spectrum of the granularity and the sine-wave response; data adequate for the calculation of these functions were published in 1958. The results obtained hold only if messages recorded on the film are coded in an optimal way. No optimal methods of coding are known, but methods that are close to optimal have been developed. It is known that when optimal coding is employed, nearly every message looks just grainy film. After the problem is formulated in mathematical the chief mathematical problem is that of selecting the optim of messages; this is done with the help of the calculus of vari A photographic film is a peak-limited recording channel: the is limited in both directions. The theory of information capac not yet adequately developed for such channels; the calculatio actually based on the existing formulae for mean-square-limi channels; at the end of the calculation an ad hoc correction is to take account of the peak limiting. Photographic films are linear in at least two different ways: the noise (granularity) on the signal, and the output (density) is a nonlinear function input (exposure). It is shown that the first nonlinearity may unloaded on the second, so that only the input—output nonlinea remains.

16129 PHOTOGRAPHIC RESPONSE TO SUCCESSIVE EXPOSURES OF DIFFERENT TYPES OF RADIAT M.Ehrlich and W.L.McLaughlin.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1172-81 (Nov., 1961).

Given the photographic response curves characteristic fo two types of radiation, it is possible to predict the course of density-versus-exposure curves produced by the two types of radiations in sucession, and thus, tentatively, to draw conclus as to the behaviour of the latent image. The results of succes exposures to X and gamma radiation of different photon energ intensity, to gamma radiation and visible light, and to visible and infrared radiation show that — after some initial transiti phenomena — the shape of the density-versus-exposure curve essentially the same as that of the curve corresponding to the second type of exposure, administered alone. In the region of transition, changes in the curve shape may occur which sugges transformations of the latent image, leading to photographic sensitization, desensitization, or reversal. Some of the doubl exposure effects found in the literature are discussed in relat the data.

16130 FOCAL TOLERANCES AND BEST FOCAL SETT FOR MODEL PHOTOGRAPHIC IMAGES WITH PRIMARY SPHERICAL ABERRATION. E.H.Linfoot.
Optica Acta (Internat.), Vol. 8, No. 3, 233-53 (July, 1961).

The question of focal depth and best focal setting in photo graphic images is of importance to optical designers because connection with the problem of obtaining a satisfactorily flat and it would evidently be a great convenience to be able to pr without constructing a trial model, the best focal surface and focal depth in different parts of the field of a photographic de working with a specified emulsion. Recent developments in o theory and in computing techniques suggest that this old prob could now be attacked again with better hope of success. A combined attack from the theoretical and experimental sides to be needed. A beginning on the theoretical side is attempte present paper, in which the dependence of focal depth and bes setting on photographic spread and noise is examined comput in selected model photographic images with 0, 1, 2 and 4 wav lengths respectively of primary spherical aberration. Two d ent model emulsions are used to receive each image. The cr of focal depth adopted is that the image quality (in a precisely defined sense) shall not fall below 80% of that at best focus; t curves given also allow the focal depths corresponding to oth percentage criteria to be read off for the images considered. different measures of image quality are used and compared. first is a generalization of the Strehl intensity ratio; the seco measure of the discriminating power of the model photograph system, used on a random object set of specified mean contra third evaluates the quality of the image by means of its norm structural resolution. Only the second of these evaluations i sufficiently refined to take account of the fact that the focal d of the system and the position of best focus may change when noise-level in the receiving surface is altered. One of the re of the present investigation is that these changes are of little practical consequence provided the amount of fourth-power aberration does not exceed two wavelengths. The three differ image-quality evaluations then lead to nearly the same conclu and it seems that one can predict the focal depth sufficiently from a knowledge of the focal ratio, the aberrations, and the contrast transfer function of the receiving surface, without s ing the ratio of object contrast to emulsion noise. In systems four wavelengths of spherical aberration, the focus of best di mination may change considerably, and the focal depth appre when the noise-level in the receiving surface is varied. In a

e xamined the focal depth depends rather sensitively on the spread in the receiving surface. It appears that one wave- of primary spherical aberration (the Rayleigh limit) can he image quality at best focus appreciably even when photo- spread is large compared with diffraction spread and the s noisy.

INTERPRETATION OF SOME PROPERTIES OF
1 31 IMAGES OBTAINED IN EXPERIMENTS ON REMOVAL T STRUCTURE FROM HALF-TONE IMAGES.
quet and J.Tsujiuchi.
Acta (Internat.), Vol. 8, No. 3, 267-77 (July, 1961).
nch.
ontrast reversal, edge effects, etc., are shown by diffraction to be explained by the way in which the dots in the half-tone are formed from the original picture. Experiments in which nt order spectra were masked off confirmed these ideas.
W.T.Welford

HEAT . RADIATION

STUDY OF THERMAL CONDUCTIVITY GAUGE: THE
132 THERMOCOUPLE GAUGE.
artin and J.L. de Segovia.
al Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 5-6, 151-8 June, 1960). In Spanish.
he effects of varying the length and diameter of the electrically l constantan filament, the filament temperature (50° to 300°C), ambient temperature, and the nature of the contained gas (air, nd butane), on the sensitivity of a Pirani gauge, were studied imentally. The pressure was measured on a McLeod gauge e filament temperature thermoelectrically. S.Weintroub

MEASUREMENT OF THERMAL CONDUCTIVITIES IN
133 THE UNSTEADY STATE. J.C.Perron.
Acad. Sci. (France), Vol. 252, No. 19, 2867-9 (May 8, 1961).
nch.
he application of Angström's method to the measurement of ermal conductivity of short (3 cm long) semiconductor nens, is discussed. The theory and a suitable experimental gement are described. Results obtained for the thermal ctivities of Pb, Si, Ge, InSb, Mg_2Sn and Mg_2Ge at 300°K are
S.Weintroub

MEASUREMENT OF THE THERMAL CONDUCTIVITY
134 OF CONDUCTORS AT HIGH TEMPERATURES.
tinet.
ys. Radium (France), Vol. 22, Suppl. No. 6, 115A-120A (June, . In French.
The measuring difficulties are reviewed; these are due to para- heat losses which cause large inaccuracies. The methods of ustained sinusoidal signal and of the periodic signal provide s of evaluating these losses. The second method may be adapt- samples of reduced length and with caution it is possible to iment at high temperature (as high as 1000°C) while retaining dvantages of simplicity and rapidity.

A NON-STEADY-STATE METHOD FOR MEASURE-
3135 MENT OF THE THERMAL CONDUCTIVITY OF
IDS AND GASES. P.Grassmann and W.Straumann.
nat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 50-4 (June, . In German.
The method is an extension of the well-known non-steady-state ire method. The equipment developed for this purpose offers mple practical means for obtaining rapid and exact measure- s: with heating for only a few seconds, the thermal conductivity an accuracy of ±1% can be read off directly from an instru-

STEADY-STATE HEAT FLUX GAUGE.
6136 E.A.Brown, R.J.Charlson and D.L.Johnson.
sci. Instrum. (USA), Vol. 32, No. 8, 984-5 (Aug., 1961).
The gauge is essentially several platinum resistance thermo- rs (constructed by modern techniques) mounted on opposite s of a disk (0.25" diam. × 0.020" thick) of Pyroceram. This is hed to the appropriate part of the equipment taking precautions against producing a "hot spot" due to disturbing the heat flow. A probable error of 17% is quoted, at least 10% of this, it is claimed, being due to uncertainty in the value of the thermal conductivity of the disk. E.G.Knowles

ON THE SO-CALLED STAGNATION CONDITIONS AND
16137 ENERGY (HEAT) FUNCTION IN DIABATIC FLOW.
M.Z.v.Krzywoblocki.
Acta phys. Austriaca, Vol. 14, No. 2, 212-17 (1961).
Discusses some characteristic properties of a diabatic flow, in particular, the stagnation conditions and the behaviour of the energy function (heat added from outside). It is shown that, in general, it is impossible to define a unique stagnation temperature, and that the added energy (heat) function along a streamline is actually a function of one independent variable only.

THE PROPAGATION OF AN APPROXIMATELY
16138 SPHERICAL HEAT FRONT.
R.M.Zaidel', O.S.Rŷzhov and É.I.Andriankin.
Dokl. Akad. Nauk SSSR, Vol. 124, No. 1, 57-9(Jan. 1, 1959).
In Russian.
Begins with the known solution for the propagation of a spherical heat front, and considers small perturbations about this solution. Seeks a solution of the resulting linear equation by the method of separation of variables and is able to reduce the problem to the solution of the hypergeometric equation. The physical condition that the solution must be regular within a certain domain leads to an eigen-value problem. [English translation in: Soviet Physics—Doklady (USA), Vol. 4, No. 1, 65-7 (Aug., 1959)]. N.Curle

HIGHLY INTENSIVE HEAT AND MASS TRANSFER IN
16139 DISPERSED MEDIA. Y.Mikhailov.
Internat. J. Heat. Mass Transfer (GB), Vol. 1, No. 1, 37-45 (June, 1960).
A solution is given for a system of differential equations for heat and mass transfer in a dispersed medium in the presence of phase conversions (the evaporation of liquid or steam condensation). The mass transfer is thought to occur under the effect of mass transfer potential gradient $\nabla\theta$, a temperature gradient ∇t and a total pressure gradient ∇p. Solutions are obtained for the heat and mass transfer potentials (t, θ, p) applicable to a one-dimensional problem (an infinite plate and a sphere) with boundary conditions of the third order. The solutions are given in the criterion form using heat and mass transfer similarity criteria. An analysis is given of the effect of the separate similarity criteria (Bi_q, Bi_m, Pn, Lu_p) on the fields of heat and mass transfer potentials. The effect of molar (filtration) transfer on heat and mass transfer is shown.

A PROBLEM IN HEAT TRANSFER.
16140 I.J.Kumar.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 4, 414-21 (July 26, 1960).
The theoretical temperature distribution in a gun barrel is obtained by assuming it to be a hollow semi-infinite cylinder. The outer surface of the cylinder is taken to be at a temperature zero, while at the inner surface of the cylinder, the temperature up to the instantaneous position of the shot is considered to be T_0 and zero in the rest of the cylinder. Both the radial and axial flow of heat are taken into account.

TRANSFER OF HEAT BELOW 0.15°K.
16141 A.C.Anderson, G.L.Salinger and J.C.Wheatley.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1110-13 (Oct., 1961).
The transfer of electrically-supplied heat from a copper thermal link into single-crystal slabs of chromium potassium alum was measured in the temperature range from 0.03° to 0.15°K. Temperature differences produced by heating were less than 6% of the average temperature. The heat transfer rate per unit temperature difference is characteristic of two thermal conductances in series with a heat sink. One of the conductances is characteristic of electrical-purity copper and is ascribed to the copper thermal link. The second corresponds to a heat transfer rate per unit teperature difference and per unit contact area of $3 \times 10^5 T^3$ erg $sec^{-1} cm^{-2} deg K^{-4}$. Comparison with other experiments leads to the conclusion that heat flow rates into single crystals of ferric alum and chrome alum are proportional to the contact area with the thermal link and are reasonably reproducible from experiment to experiment. In the present experiments it is likely that classical thermal diffusion does not determine the flow of heat within the alum crystals. Instead, the experiments suggest that the T^3 thermal conductance is a boundary effect and

that the phonon mean free path within the chrome alum crystals is sufficiently long to insure that the crystal temperature is homogeneous.

HEAT TRANSFER IN EXPANDING COMPRESSED GAS.
See Abstr. 15950

SOME PROBLEMS ASSOCIATED WITH THE DEFINITION OF THE HEAT OF TRANSFER FOR BINARY LIQUID SYSTEMS.
See Abstr. 15856

16142 STEADY TEMPERATURE IN A THREE-LAYERED STRIP. V.Vodička.
Acta phys. Austriaca, Vol. 14, No. 2, 175-8 (1961).

The general theoretical deductions concerning steady thermal processes in an n-layered doubly infinite strip are applied to a three-layer plate. The results are complicated and a considerable part of the material has not yet been given in the literature.

16143 CONVECTION OF HEAT IN A FLUID WITH CONSTANT PHYSICAL PROPERTIES UNDER LAMINAR CONDITIONS WITH ANY PRESSURE GRADIENT AND WALL TEMPERATURE. B. le Fur.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 68-80 (June, 1960). In French.

Integration by successive approximations of the laminar boundary layer equations enables one to calculate, for any pressure gradient, the friction and convection coefficients, the effective temperature and the recovery factor.

CONVECTION WITH CHEMICAL REACTION.
See Abstr. 15190

16144 TEMPERATURE BEHAVIOUR OF BOILING LIQUIDS IN DEWAR FLASKS. E.Donth.
Ann. Phys. (Germany), Vol. 8, No. 1-2, 104-10 (1961). In German.

An experimental study was carried out on the temperature gradient and convection processes in liquid oxygen boiling in a cylindrical Dewar vessel. The results show a high temperature gradient (up to 0.1 deg mm^{-1}) near the top surface and an appreciable temperature difference (up to 0.6 deg) between the bulk liquid and the vapour. The hydrodynamical aspects are discussed and theory is shown to account in principle for the observations. L.Mackinnon

16145 BALLISTIC EQUATION OF HEAT, FOLLOWING THE LINES OF FLUX IN THE CASE OF STABLE LINES OF FLUX, AND REACHING A UNIVERSAL IMPULSE EQUATION. F.Camia.
J. Phys. Radium (France), Vol. 22, No. 5, 271-8 (May, 1961). In French.

Considers the flow of heat through flux tubes of any geometrically stable form (even the quantity of heat passing may be variable, and consequently the temperature), conductivity and thermal capacity supposed invariable. The general solution of the heat equation for one specified tube can always be expressed as the sum of products of a "U_p" function of the abscissa (taken over the length of the tube) with an exponential of time. The universal equation is given in order to determine the "U_p". It is an equation of the Sturm-Liouville type, comprising as independent variable the abscissa, as auxiliary functions the section of the flux tube (an arbitrary function of the abscissa) and its derivative, and as parameter the proper value of each "U_p" fixed by the boundary conditions. The coefficients of the terms of the sum are classical. The exponential of time is entirely determined by the proper values of "U_p". It is now possible to calculate the effects of a thermal pulse localized in space and in time. By integrating, a universal equation of heat is given for each of the cases surveyed. The classical equations (Fourier, Bessel and so on) are only particular cases. A hyper-space, or a curved space of n dimensions, is treated by means of simple recurrence laws. The elementary pulse itself is expressed by the sum of "U_p" functions whose coefficients do not necessitate integration. Apart from the problem of heat, the interest of this method resides in the fact that it allows of solution all similar diffusion problems and that it can be used in all the wave mechanical equations which are "U" functions.

16146 USE OF STOKES' STREAM FUNCTION FOR DISCONTINUITIES OF POTENTIAL AT A SPHER BOUNDARY. G.Power and H.L.W.Jackson.
Appl. sci. Res. B (Netherlands), Vol. 8, No. 5-6, 463-6 (1960

A use of Stokes' stream function is here presented whic for discontinuities of potential at a spherical surface of sepa It is of special importance in heat problems where the "radi boundary condition applies. Results obtained previously dep upon the continuity of potential across the surface can also b deduced. The fact that "flow-sheets" can be determined dire from the given formulae is often advantageous.

16147 EXPERIMENTAL METHODS APPLIED TO THE DETERMINATION OF SOME TEMPERATURE RADIATION PARAMETERS. D.T.Kokorev.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 23-7 (Ju 1960).

The analytical determination of integral angular radiatio factors is very complicated for most practical cases. The k graphical and analytical methods do not present a satisfactor solution of problem as a whole. The writer makes an attemp solve the problem experimentally. Analytical relations were obtained, which make it possible to establish simple experim methods of determining angular radiation factors for a gener case of a spatial problem, which plays an important role in t solution of engineering problems of heat transfer by radiatio In addition, it was possible to find the optical characteristics grey surfaces; the average factors of absorption, reflection radiation.

16148 THERMAL RADIATION BETWEEN PARALLEL SEPARATED BY AN ABSORBING–EMITTING N ISOTHERMAL GAS. C.M.Usiskin and E.M.Sparrow.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 28-36 (1960).

A complete formulation, including the local details of ga absorption–emission processes, is made for thermal radiat a parallel plate enclosure. The temperature is permitted to continuously between the plates, and the emissive power of t may have an arbitrary dependence on temperature. Therma ductivity effects are omitted. Solutions of the governing inte equations are carried out for values of the single governing meter kL (k = absorption coefficient, L = spacing) in the ran 0.1 to 2.0. Temperature distributions and heat transfer resu are given. For moderate values of kL, the temperature is q uniform across the gas.

16149 ONE-DIMENSIONAL ENERGY TRANSFER IN RADIANT MEDIA. R.Goulard and M.Goulard.
Internat. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 81-91 (1960).

The equations of one-dimensional radiative energy trans are extended from their classical astrophysics form to inclu of arbitrary radiative properties. The concepts of emissivit and penetration length are examined. As an application, the the steady infinite flat layer is considered, with conduction a radiation present. The wall conditions are so chosen as to good model of a low-speed high-temperature boundary-layer found that the effect of the "long-range" process of radiation smooth out the temperature profiles and relieve the sharp te ture gradients at the cool wall. As a result, the application exact method yields a lower value of both components of the heat flux (radiation plus convection) than calculated previous assuming a temperature profile on the basis of conduction o Such coupling of convective and radiative fluxes is governed magnitude of a non-dimensional parameter, depending on the properties and the flow geometry of the problem.

16150 RADIANT FLUX FROM A CYLINDRICAL DISTR SOURCE. W.R.Anderson and I.B.Berlman.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1229-34 (Nov., 1961).

Of the total radiant flux produced in a right-circular cy cell containing a uniformly distributed isotropic source of r energy, the fraction emanating from the end window is comp for a cell with ideal, perfectly reflecting mirror surfaces a cell with ideal, totally absorbing surfaces. Graphs are pres of the calculated radiant-flux fractions from the cylinder as function of the absorbance of the contents. Also presented a of measurements of the radiant flux emitted from a cylindri containing an externally excited scintillating solution when t

ing surfaces of the cell are (1) polished aluminium, (2) alumin-
aporated on glass, (3) aluminium oxide, and (4) Teflon. These
. are expressed relative to the radiant flux emitted by the
:ell—solution combination with blackened inner cell surfaces.
tual radiant-flux fractions emitted by the cells are estimated
ıg the calculation for a cell possessing ideal, totally absorbing
es.

51 TWO-STAGE RADIANT-ENERGY SINK.
J.F.Hall, Jr.
Soc. Amer., Vol. 51, No. 11, 1298-9 (Nov., 1961).
method is described for absorbing radiant energy by means
ir of radiant energy sinks maintained at different tempera-
: A dispersive element separates the incident energy into
velength bands. Each band is absorbed by a heat sink that
k for that band, and has low emissivity in the wavelength
of the other band so that it does not radiate. The major
ı of the heat load is removed by the high-temperature sink,
he apparent temperature of the system is nearly equivalent
low-temperature sink. The conventional system, by contrast,
es all the radiant energy by means of a single heat sink at a
·ature sufficiently low to cool the lowest energy source.

52 EMISSIVITY ERRORS OF INFRA-RED PYROMETERS IN RELATION TO SPECTRAL RESPONSE.
eynolds.
. appl. Phys., Vol. 12, No. 8, 401-5 (Aug., 1961).
ıe emissivity errors of total, partial and monochromatic
on pyrometers for use in the temperature range 500-800°K
ıscussed theoretically. The pyrometer output is expressed as
r law of absolute temperature with an exponent n which varies
mperature and the spectral response of the pyrometer. The
vity error ıcreases as n increases. It is shown that n
ses as the spectral response of the pyrometer is restricted
:ter wavelengths in the near infrared region.

53 INFRARED DETECTORS BASED ON PHOSPHORS.
R.Groth.
urforsch. (Germany), Vol. 16a, No. 2, 169-72 (Feb., 1961).
man.
·S:Ce,Sm is alternately excited by ultraviolet at 3000 A, and
ed to infrared while its stimulated output falls on a photo-
lier. Phosphorescence raises the dark current in the
or and is minimized by reducing the ultraviolet level. For
ıosphor the maximum sensitivity is at 1 μ, and at 600 c/s
ion 6×10^{-11} W can be detected. S.T.Henderson

54 FLAME SPEEDS IN OSCILLATING GASES IN A TUBE.
K.K.Prasad, K.Mahadevan and H.A.Havemann.
an Inst. Sci. Vol. 43, No. 1, 26-43 (Jan., 1961).
low disturbances such as turbulence, have long been known to
mportant effects on flame propagation, affecting in particular
me speed. Due to the difficulty associated with measuring
ence and describing its effect on such a complex phenomenon
ame, it has been pointed out that useful information can be
ed by restricting the study to the interactions of a simple form
/ disturbance and a flame. This paper describes some ex-
ental studies on the influence of oscillations on an otherwise
l flame propagating from either end of a tube open an one end.
xperiments reveal that higher flame speeds invariably result
ıe imposition of oscillations irrespective of the strength of the
ıstible mixture. The flame speed increases linearly with
ncy of oscillations and the extent of this increase is determin-
mixture strength. Rich mixtures show increasing flame
s with increasing amplitudes, while lean mixtures exhibit a
al amplitude at which maximum flame speed occurs.

55 FLUCTUATIONS OF THE IGNITION POINT OF A COMBUSTIBLE MIXTURE IN THE SELF-IGNITION BY S WAVES. K.Terao.
s. Soc. Japan, Vol. 15, No. 9, 1710-11 (Sept., 1960).
man.
short description of the experimental set-up is given. By
ging one photomultiplier in the direction, the other one
ndicular to the flow, the ignition-point distribution can be
red in a shock tube (reflected waves). The results agree
well with the fluctuations of the induction time of the same
stible mixture, as determined previously by the author
. 9170 of 1961). C.B.Ludwig

16156 ONE-DIMENSIONAL LAMINAR FLAME PROPAGATION WITH AN ENTHALPY GRADIENT.
J.Adler and D.B.Spalding.
Proc. Roy. Soc. A (GB), Vol. 261, 53-78 (April 11, 1961).
Exact numerical solutions of the flame equations are presented for a class of one-dimensional pre-mixed steady flames propagating in the presence of an enthalpy gradient. It is shown that a positive enthalpy gradient increases the flame speed whereas a negative gradient decreases it to zero, the latter result occurring at a finite value of the dimensionless enthalpy-gradient parameter. The physical significance of the results is discussed quantitatively for the following cases: flow of a combustible gas into a hot plug: flow of a combustible gas into a cold plug; the "sandwich burner" (flame between two cooled plugs); radiative heat loss from the combustion products; burning of a condensed-phase propellant in an atmosphere with which the decomposition products can react chemically. It is shown that some of these conditions lead to the existence of two possible burning velocities, and to conditions under which the flame will be extinguished.

16157 AN A.C. MODULATED FLAME IONIZATION TRIODE.
J.Middlehurst and B.Kennett.
Nature (GB), Vol. 190, 142-3 (April 8, 1961).
The ionized flame is shot from a hypodermic needle through a modulating grid consisting of a helix of platinum wire on to a platinum gauze anode. When the grid is modulated by low frequency a.c., small changes in anode current can be measured by usual techniques. The output signal is proportional to the gas flow and it is estimated that a flow rate of 10^{-13} g/sec of ethylene can be detected. D.Walsh

16158 ON THE ACCURACY OF REALIZATION OF THE INTERNATIONAL TEMPERATURE SCALE ABOVE 1063°C. T.P.Jones.
Austral. J. appl. Sci., Vol. 12, No. 2, 141-7 (June, 1961).
Details are given of the apparatus used in the realization of the International Temperature Scale above 1063°C at the Australian National Standards Laboratory. The final accuracy of calibration of the precision optical pyrometer is ±3 deg C for 90% confidence limits in the range 1063 to 1600°C and ±5 deg C in the range 1600 to 1950°C.

"1958 He^4 SCALE OF TEMPERATURES".
See Abstr. 16183

16159 BIBLIOGRAPHY OF TEMPERATURE MEASUREMENT, JANUARY 1953 TO JUNE 1960.
C.Halpern and R.J.Moffat.
Nat. Bur. Stand. (USA), Monogr. No. 27, 13 pp. (1961).
The 500 references were collected from scientific and technical literature, and from government reports. The references are divided into a number of categories based on the type of instrument used; some reference to calibration of instruments and to scientific theories, on which temperature measurement is based, are also presented.

16160 SPECTROSCOPIC METHODS OF MEASUREMENT OF HIGH TEMPERATURES.
M.L.N.Sastri and A.S.Nagarajan.
Defence Sci. J. (India), Vol. 10, No. 3, 259-73 (July, 1960).
Review, referring mostly to line intensities, line widths and line profiles.

A METHOD FOR MEASUREMENT OF THE TEMPERATURE DISTRIBUTION OVER THE SURFACE OF PLANE THERMIONIC CATHODES OF VERY SMALL DIMENSIONS. See Abstr. 16366

TEMPERATURE MEASUREMENTS OF SHOCK WAVES AND DETONATIONS BY SPECTRUM-LINE REVERSAL.
See Abstr. 15943

16161 ATTAINMENT OF PRECISION TEMPERATURE REGULATION BELOW AMBIENT. J.Gasnier.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 13A-16A (Feb., 1961). In French.
For studying the magnetic after-effect between −50°C and room temperature, the author stabilized the temperature of a cavity with an accuracy of ± 0.002 deg C. This accuracy has been achieved by adding to the regular feedback loop a second loop to take care of the

slow drift. The apparatus is entirely automatic and battery powered. It can be used for experiments lasting up to 48 hours.

16162 PRECISION THERMOSTAT FOR THE FREQUENCY STANDARDS. Y.Hiruta.
J. Radio Res. Lab. (Japan), Vol. 7, 111-24 (March, 1960).

The object of this study is to improve the thermostatic control of frequency standards, and to decrease temperature variations due to the ambient temperature change. The method is to compensate the temperature variations with a thermo-sensitive device which is sensitive to the temperature in the environment. This method of compensation is shown by two examples; one is a thermostat using mercury-in-glass contact thermometers, and the other uses resistance thermometers. Although these thermostats are composed of a single oven each, they have very little temperature variation as compared with conventional thermostats with double ovens.

16163 AN INDUCTION FURNACE TO ATTAIN TEMPERATURES ABOVE 3000°C IN CONTROLLED ATMOSPHERES.
L.C.F.Blackman, P.H.Dundas, A.W.Moore and A.R.Ubbelohde.
Brit. J. appl. Phys., Vol. 12, No. 8, 377-83 (Aug., 1961).

An induction furnace operating at 500 kc/s is described which is capable of providing temperatures in excess of 3000°C at high vacuum or in any suitable gas mixture at pressures up to 8 atmospheres. The work coil is mounted inside the furnace chamber, which can then be designed as a pressure vessel and constructed of electrically conducting steel. By this technique close coupling is provided between the work coil and the susceptor crucible: if desired, a heat treatment cycle to 3000°C can be completed in less than one minute. To avoid any contamination, the furnace is thermally uninsulated, so that all the heat dissipated in the crucible is lost by radiation, limiting its total surface area to about 20 cm^2 for temperatures of 3500°C with a 25 kW generator. Application of the theory of induction heating shows that the effective resistance of the susceptor crucible can be increased by several methods, thus improving the heating efficiency of the furnace. The theory may also be applied for determining the resistivities of various susceptor materials at very high temperatures.

CREATION OF HIGH TEMPERATURES BY INTERNAL FRICTION. See Abstr. 14852

16164 SMOOTH POWER CONTROL FOR HIGH CURRENT FURNACES. B.Riley.
J. sci. Instrum. (GB), Vol. 38, No. 9, 357-8 (Sept., 1961).

A method is described whereby the temperature of resistance furnaces operating with currents of 500 to 2000 A can be adjusted continuously and smoothly. The furnace power is supplied from a saturable reactor, the output of which is controlled by a manually operated or motor driven auto-transformer in series with a rectifier. The system described will provide power output voltage supplies which vary as the first, second or third power of time, in response to impulses from a thermocouple or total radiation pyrometer.

16165 SEMI-MICRO ROCKING-BOMB CALORIMETER FOR HEAT OF SOLUTION MEASUREMENTS. J.Hietala.
Ann. Acad. Sci. Fennicae A VI (Finland), No. 63, 56 pp (1960).

A detailed description of the construction and use of a one-vessel calorimeter with thick walls, such that the heat capacity of the solid part is of the same order of magnitude as that of the water it contains. Heats of solution of the order of 200 joules can be measured. The associated equipment including a thermostat, operating on thermistors and with a precision of 0.001°C, a special dissolving device, and a dual system of temperature measurement, are described in detail. To check the performance of the calorimeter the heats of solution of KCl and KBr at 25°C were determined in air-saturated water. The values obtained were 17562 and 20049 joules/mole respectively for a mole ratio of 1:200.

S.Weintroub

16166 MEASUREMENT OF TRUE SPECIFIC HEATS BY MICROCALORIMETRY.
E.Calvet and N.Tikhomiroff.
C.R. Acad. Sci. (France), Vol. 252, No. 25, 3952-4 (June 19, 1961). In French.

Discusses the advantages of heating (or cooling) the experimental cell by means of the Peltier effect. S.Weintroub

16167 AN ADIABATIC CALORIMETER.
P.Berge and G.Blanc.
J. Phys. Radium (France), Vol. 21, Suppl. No. 7, 129A-133A (July, 1960). In French.

An adiabatic calorimeter has been designed for the range 80° to 800°K. It allows determination of specific heat or heat content of solid or powdered samples and their anomalies with the accuracy of presently available milliwattmetric equipment. Extension of the temperature range is contemplated.

16168 METHOD OF LINEARIZING THERMISTOR THERMOMETER DATA IN CALORIMETRY.
H.V.Larson, I.T.Myers and W.H.Le Blanc.
J. sci. Instrum. (GB), Vol. 38, No. 10, 400-1 (Oct., 1961).

A method of correcting for non-linearity is described. The correction may either by experimentally determined, or calculated from the thermistor specifications. This system of reducing thermistor data was applied to measurements over temperature differences of several degrees in two different adiabatic calorimeters. A linear temperature resolution of 10^5 to 1 was easily obtainable.

16169 PRECISE MEASUREMENT OF HEAT OF COMBUSTION WITH A BOMB CALORIMETER. R.S.Jessup.
Nat. Bur. Stand. (USA), Monogr. No. 7, 23 pp. (1960).

Gives detailed descriptions of apparatus and methods used at the National Bureau of Standards for precise determinations of heats of combustion of liquid hydrocarbon fuels. Numerical examples are given of methods of calculating results of measurements from observed data. The technique of making and filling glass bulbs to contain samples of volatile liquid fuels is described. The accuracy of the methods described is about 0.1% attained in certain measurements on pure compounds, and the accuracy of several tenths of one percent obtainable with published standard procedures for measurements on fuels.

16170 HIGH-TEMPERATURE CALORIMETER FOR THE DETERMINATION OF HEATS OF FORMATION OF REFRACTORY COMPOUNDS. C.E.Lowell and W.S.Williams.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1120-3 (Oct., 1961).

A high-temperature calorimeter was built to measure the heats of formation of certain refractory compounds (by direct reaction of the elements) at temperatures in excess of 1000°. The standard heat of formation of TiB_2 was found to be -50 ± 5 kcal $mole^{-1}$. A known heat of formation, that of TiC, also measured, yielding reasonable agreement with the literature value.

STABILIZED POWER SUPPLY FOR MICROCALORIMETRY. See Abstr. 16214

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

16171 STRUCTURAL EFFECTS IN THE VAPOR PRESSURES OF ISOTOPIC MOLECULES. O^{18} AND N^{15} SUBSTITUTION IN N_2O. J.Bigeleisen and S.V.Ribnikar.
J. chem. Phys. (USA), Vol. 35, No. 4, 1297-1305 (Oct., 1961).

The relative vapour pressure ratios of the isotopic N_2O molecules were determined by distillation in a column under total reflux. It is shown that the vapour pressures are in the sequence

$$N^{14}N^{14}O^{16} > N^{14}N^{15}O^{16} > N^{15}N^{14}O^{16} > N^{14}N^{14}O^{18}.$$

The absolute vapour pressure ratios were determined from the kinetic behaviour of the column and the decrease in separation production from the column. Theoretical calculations of the vapour pressure ratios can be made from the atomic masses and the random structure of liquid N_2O. The calculated relative effects are in good agreement with experiment. The absolute value of $\ln P_{N^{14}N^{14}O^{16}}/P_{N^{14}N^{15}O^{16}}$ is calculated from the specific heat of N_2O to be 8.2×10^{-4} at 184°K, in good agreement with the experimental value $7.8 \pm 1.4 \times 10^{-4}$. The difference in vapour pressures of the isotopic isomers $N^{14}N^{15}O^{16}$ and $N^{15}N^{14}O^{16}$ is attributed to hindered rotation of the molecule in the liquid.

172 INSTRUMENT FOR THE MEASUREMENT OF THE HEAT OF VAPORIZATION OF WATER.
ieman and A.Lavie.
J. Phys., Vol. 29, No. 10, 705-6 (Oct., 1961).
escribes an apparatus constructed so that the steam passed
e calorimeter is (a) passed through a water droplet trap,
cketed" by steam until admission to the calorimeter. Results
en 521 and 534 cal/g are quoted. E.G.Knowles

6173 VAPORIZATION PROCESSES IN THE HYPERSONIC LAMINAR BOUNDARY LAYER.
cala and G.L.Vidale.
at. J. Heat Mass Transfer (GB), Vol. 1, No. 1, 4-22 (June,
he net aerodynamic heat transfer into the surface of a vapor-
material depends critically on the blocking action due to the
ning of the boundary layer and on the heat absorbing capacity
chemical species injected into the boundary layer during the
ization process. An analysis of the phenomenon of vaporization
sented for hypersonic flight conditions, and numerical solutions
resented for mass transfer at the stagnation point of an
y-symmetric vehicle. These results were obtained by solving
rtinent boundary layer equations for diffusion, convection and
al exchange, subject to the appropriate physicochemical
raints arising from the kinetics of vaporization. In addition,
ersal solution is given, in terms of the most significant
endent parameters, which defines the flight regimes where the
ization process is diffusion controlled, kinetically limited,
th. Utilizing the general correlation formula derived herein,
ay estimate the rate of vaporization of an arbitrary material,
ct to hypersonic flight conditions, provided only that one has an
endent knowledge of certain minimum physiochemical data.

6174 STUDY OF THE EUTECTIC MELTING IN THE Fe—C SYSTEM BY CONTINUOUS CALORIMETRY. M.Genot.
Acad. Sci. (France), Vol. 252, No. 17, 2520-2 (April 24, 1961).
nch.
The heat of fusion of the Fe—cementite eutectic was measured
he value used in a thermodynamic study of the eutectic point.
es of the heats of solution of iron, graphite and cementite were
ced and the liquidus of the metastable cementite was plotted.
A.E.Kay

6175 MELTING AND CRYSTAL STRUCTURE: VOLUME CHANGES ON MIXING NITRATE MELTS.
eaver, E.Rhodes and A.R.Ubbelohde.
. Roy. Soc. A (GB), Vol. 262, 435-42 (Aug. 8, 1961).
Measurements were made of the densities of liquid potassium
ıte containing up to 50 equivalents per cent of barium nitrate.
in the temperature range from the liquidus to 440° C, isotherms
quivalent volume as a function of equivalent composition were
d to be straight lines. The excess volume of mixing for any
of melts in this composition range is thus zero. Partial equiva-
volumes of both components are independent of composition at
ven temperature, and are given by

$$\bar{V}_m(KNO_3) = 53.17 + 0.0229(t - 300),$$

$$\bar{V}_n(Ba(NO_3)_2) = 41.75 + 0.0107(t - 300),$$

re t is the temperature in degrees centigrade. This some-
t unusual mixing behaviour is discussed in relation to possible
ıctures for nitrate melts, and in relation to available information
ıt excess volumes of mixing for other ionic melts and liquids
erally.

16176 STUDIES ON THE FREEZING OF PURE LIQUIDS. II. THE KINETICS OF HOMOGENEOUS NUCLEATION
SUPERCOOLED LIQUIDS. E.R.Buckle.
c. Roy. Soc. A (GB), Vol. 261, 189-96 (April 25, 1961).
For Pt I, see Abstr. 8266 of 1961. A modified form of Turnbull
Fisher's equation (Abstr. 3166 of 1949) for the rate of nucleation
ure liquids is derived from the more general solution of Frenkel
he non-equilibrium steady-state kinetic problem. Recent devel-
ients in relaxation theory, based on the Zeldovich—Frenkel form-
ion of the time-dependent flow of embryos over the size variable
how that under certain conditions the nucleation time lag may be
eedingly sensitive to the initial state of the condensing system.
sch's integral for the nucleation time lag is evaluated for two
ial distributions of embryo size. The results, which are of general form, are used to derive expressions for the time lag in supercooled liquids. Methods are given for estimating certain parameters required in the computation of time lags in supercooled liquids.

16177 STUDIES ON THE FREEZING OF PURE LIQUIDS. III. HOMOGENEOUS NUCLEATION IN MOLTEN ALKALI HALIDES. E.R.Buckle and A.R.Ubbelohde.
Proc. Roy. Soc. A (GB), Vol. 261, 197-206 (April 25, 1961).
Current methods of interpreting critical supercooling are discussed. In the method of Turnbull it is assumed that the experimental observation time matches the reciprocal of the steady-state nucleation frequency. This assumption is shown to be incompatible, for certain types of experiment, with the nucleation time lag predicted by the theory of Pt II. An alternative criterion of freezing which avoids this difficulty is that under the conditions of a threshold experiment the observation time is comparable with the nucleation time lag. This criterion may be used in conjunction with the theory of Pt II to interpret critical supercoolings without making separate assumptions about nucleation frequencies. Threshold nucleation rates, sizes of crystal nuclei, and liquid-solid interfacial free energies for alkali halids are calculated from the supercooling data of Part I. Data for nuclei are examined in relation to the properties of the liquid and solid compounds in bulk form. Certain outstanding problems in the interpretation of results obtained in this and other studies are discussed with respect to present nucleation theory.

16178 THE PROPERTIES OF ARGON AT ITS TRIPLE POINT. E.A.Guggenheim and M.L.McGlashan.
Molecular Phys. (GB), Vol. 3, No. 6, 571-6 (Nov., 1960).
Using the interaction energy between argon atoms deduced in a previous paper from the properties of the crystal and the gas and regarding the liquid as an approximately equimolar mixture of structures with coordination numbers z = 12 and z = 8 the total energy of the liquid at the triple point is calculated and found to be in good agreement with experiment.

16179 CRITICAL PHENOMENA IN THIN FILMS USING THE BRAGG—WILLIAMS APPROXIMATION.
K.Nishikawa, D.Patterson and G.Delmas.
J. phys. Chem. (USA), Vol. 65, No. 7, 1226-31 (July, 1961).
The critical properties of thin films of binary regular solutions are treated using the Bragg—Williams approximation. The lowering of the critical solution temperature is discussed as a function of film thickness, surface tension of the pure components and adsorption properties of a supporting solid substrate. The possibility of the existence of more than one critical point is considered.

THERMODYNAMICS

(See also Statistical Mechanics)

16180 A REMARK ON THE THIRD LAW OF THERMODYNAMICS. J.Kvasnica.
Czech. J. Phys., Vol. 10, No. 12, 883-6 (1960).
It is shown that Falk's formulation of the third law of thermodynamics (when the energy has minimum value the entropy is also minimum) can be replaced by an equivalent assertion: the absolute minimum energy is unattainable with a finite number of processes.

16181 AVAILABLE POWER FROM A NONIDEAL THERMAL SOURCE. P.Penfield, Jr.
J. appl. Phys. (USA), Vol. 32, No. 9, 1793-4 (Sept., 1961).
Given a reversible heat engine which makes thermal contact with its "source" and "sink" by means of fixed thermal resistances, it is shown that the efficiency at optimum power output is quite independent of the size of these resistances and is given by $1 - (T_{sink}/T_{source})^{\frac{1}{2}}$. R.O.Davies

16182 SOME REMARKS ON THE THERMODYNAMICAL INEQUALITIES. H.Wergeland.
K. Norske Vidensk. Selsk. Forhandl. (Norway), Vol. 33, No. 19, 34-6 (1960; publ. 1961).
It is pointed out that in order to get explicit necessary and sufficient conditions for stable thermodynamic equilibrium using,

for example, V and T as independent variables one must start from $\delta(U - \Theta S) > 0$, where Θ is a fixed bath temperature and where the temperature (T) of the system can be varied as well as the volume (V). The restricted principle $\delta(U - TS) > 0$ (T = const.) does not give the complete conditions. [One of the conditions obtained by the author is wrong and should be replaced by the expression $(\partial V/\partial T)_p^2 < -(C_p/T)(\partial V/\partial p)_T$.]. R.O.Davies

ON CARNOT'S PRINCIPLE AS GENERALIZED BY BRILLOUIN IN ITS APPLICATION TO THE PRECISION OF MEASURING APPARATUS. See Abstr. 15592

LOW-TEMPERATURE PHYSICS

16183 THE "1958 He^4 SCALE OF TEMPERATURES". I. INTRODUCTION. F.G.Brickwedde.
II. TABLES FOR THE 1958 TEMPERATURE SCALE.
H.van Dijk, M.Durieux, J.R.Clement and J.K.Logan.
Nat. Bur. Stand. (USA), Monogr. No. 10, 1-4, 4-17 (1960).

The generally used practical scale of temperatures between 1° and 5.2° K is the He^4 vapour pressure scale based on an accepted vapour pressure equation or table. In Sevres (near Paris), Oct. 1958, the International Committee on Weights and Measures recommended for international use the "1958 He^4 Scale" based on a vapour pressure table arrived at through international cooperation and agreement. This table resulted from a consideration of all reliable He^4 vapour pressure data obtained using gas thermometers, and paramagnetic susceptibility and carbon resistor thermometers. The theoretical vapour pressure equation from statistical thermodynamics was used with thermodynamic data on liquid He^4 and the vapour equation of state to ensure satisfactory agreement of the vapour pressure table with reliable thermodynamic data.

TRANSFER OF HEAT BELOW 0.15° K. See Abstr. 16141

16184 LEVEL GAUGE FOR LIQUID HYDROGEN AND HELIUM. R.Blanpain.
Bull. Soc. Roy. Sci. Liege (Belgium), Vol. 30, No. 5-6, 310-14 (1961).
In French.

A device depending upon the difference in power dissipation of a carbon resistor when immersed in liquid and in vapour. When the device is used in conjunction with a Wheatstone bridge, hydrogen or helium liquid levels may be detected to ±1.6 mm. The device dissipates about 6 mW at 4.2°K and 100 mW at 20.4°K. It has been used to determine the time liquefaction rate in a Collins liquifier and to monitor transfer. F.E.Hoare

16185 LIQUID HELIUM VAPOR PRESSURE REGULATOR. G.Cataland, M.H.Edlow and H.H.Plumb.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 980-2 (Aug., 1961).

A mechanical pressure regulator that may be used to control the vapour pressure above a bath of liquid helium is described. The pressure is controlled with reference to a vacuum, and may be varied by changing balance weights. Over a period of several weeks, the pressure fluctuations in a 15 litre storage flask were less than 0.007%. P.A.Walker

16186 LOW-TEMPERATURE GERMANIUM BOLOMETER. F.J.Low.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1300 et seq. (Nov., 1961).

A bolometer, using gallium-doped single crystal germanium as the temperature-sensitive resistive element, was constructed and operated at 2°K with a noise equivalent power of 5×10^{-13} W and a time constant of 400 μsec. Sensitivities approaching the limits set by thermodynamics were achieved, and it is shown that the background radiation limited or BLIP condition can be satisfied at 4.2°K. An approximate theory is developed which describes the performance of the device and aids in the design of bolometers with specific properties. The calculated noise equivalent power at 0.5°K, for a time constant of 10^{-3} sec, is 10^{-15} W. The detector is suitable for use in both infrared and microwave applications.

Liquid and Solid Helium

16187 SIMPLIFIED MODEL OF LIQUID HELIUM. K.Sawada and R.Vasudevan.
Phys. Rev. (USA), Vol. 124, No. 2, 300-7 (Oct. 15, 1961).

A simplified version of a Bose gas with negative scatteri length is studied with a model Hamiltonian similar to that use the case of repulsive interactions. A new transformation is u which takes into account the attractive interactions in the syst and the ground-state energy is calculated from experimental values of the sound velocity in the system. Real values for th phonon energy spectrum are obtained, and the ratio of the effe mass to ordinary mass is deduced using experimental values interparticle separation and core radius. A justification for u this modified Hamiltonian is attempted.

16188 ON THE DISCONTINUITY OF RELAXATION TIM AT THE λ POINT. P.Résibois and J.P.Putteman
Physica (Netherlands), Vol. 26, No. 10, 775-6 (Oct., 1960).

An attempt is made to account for the discontinuities in t transport properties of liquid helium at the λ-point. Using a "perfect gas" model a relaxation time is defined and it is sho that a discontinuity exists in the logarithmic derivative at the λ-point. It is concluded that the singularites of the transport properties arise from the collective character of the quantum transport equations and the macroscopic occupation of the gro state below the λ-point. F.E

16189 CRITICAL DRIFT VELOCITY OF IONS IN LIQUI HELIUM. G.Careri, S.Cunsolo and P.Mazzoldi.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 151-3 (Sept. 1, 1961).

The drift velocity v_D of positive ions in liquid helium II w measured in the temperature range 1.06° to 0.927° K as a func of the applied electric field. Above a critical field strength E the drift velocity no longer increases with increasing field bu suffers a discontinuity. While the value of E_c depends on tem ture, the corresponding critical velocity v_c appears to be tem ture independent, having a value of 4.7 ± 0.15 msec^{-1}. The ob drop in mobility $\mu = v_D/E$ is never larger than 10% and is onl just detectable at 1.06° K. At 0.928° K a second, smaller, dro observed at about 2 v_c. As a tentative explanation it is sugge that ions of critical velocity may excite vortex rings. This, however requires an effective mass of the ion of about 10^4 he atomic masses. The unexpectedly sharp onset of the drop in mobility also requires a large effective mass or a kind of coo tive interaction of nearby ions through long-range Coulomb fo H.

16190 CRITICAL VELOCITIES IN SUPERFLUID HELIU V.P.Peshkov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 379-81 (Jan., 19
In Russian.

A qualitative investigation of the energy—momentum rela for vortex rings indicates that the ring vortices whose format destroys superfluidity in a slit have diameters equal to the th of the slit. A three-parameter formula for the critical supe velocity v_c is obtained by assuming that the vortex acquires i energy at the expense of a fraction α of the superfluid kinetic energy in a length $R + v_c\tau$ of the slit, where R is the vortex r and τ a relaxation time of order 4×10^{-4} sec. The resulting formula agrees with a wide range of experiments. The appea of a trans-critical regime when v_s just exceeds v_c is discuss [English translation in: Soviet Physics—JETP (USA), Vol. 13 No. 1, 259-60 (July, 1961)]. O.P

16191 ON THE DENSE PHASES OF He^3 AT VERY LOW TEMPERATURES. L.Goldstein.
Ann. Phys. (USA), Vol. 14, No. 1, 77-93 (July, 1961).

A class of physical properties of the dense phases of He^3 are dominated at low temperatures by their nuclear spin syst The latter determine the lower limits of these properties, and yield thereby approximately their behaviour and limiting valu low temperatures and at the absolute zero. The theory of the system allows one to estimate the lowest temperatures at whi the various thermal properties of this class have to be deter experimentally to approach with a preset deviation their limit values in the ground state of these dense phases. These deter tions, with a common relative value of this difference, of the nuclear paramagnetic susceptibility, heat capacity, expansion

cient, and their temperature rates of variation require asingly lower temperatures, with the latter finite quantities ing temperatures one order of magnitude lower than the ptibility. These studies suggest that in order to obtain actory, experimentally inaccessible, extrapolated very low rature behaviours and finite limits of the above class of rties, careful prior analysis of their finite temperature s will have to be performed in terms of the partial properties spin systems as well as those of the degrees of freedom than spin of the dense phases of He^3.

SUPERFLUIDITY OF He^3. See Abstr. 13610

perconductivity

192 ON THE DEGENERACY OF THE SUPERCONDUCTIVE STATE. P.Mittelstaedt.
ar Phys. (Internat.), Vol. 25, No. 3, 522-8 (June, 1961).
The ground state of the BCS theory is investigated in the limit inite volume. Using a theorem of Bogolyubov it is shown that nergy density of the ground state can be obtained exactly using r states degenerate with respect to the gauge transformation state with a fixed number of particles (fermions).

193 SUPERCONDUCTOR-TRANSITION SWITCHING TIME MEASUREMENTS USING A SUPERCONDUCTIVE IO-FREQUENCY MIXER. D.L.Feucht and J.B.Woodford, Jr.
pl. Phys. (USA), Vol. 32, No. 10, 1882-7 (Oct., 1961).
The transition properties of thin superconducting tin films are rmined by measurements on a new device, the superconductive frequency mixer. An equivalent circuit for this device is ented which permits the prediction of mixer performance using c transmission curves for the particular films employed. rimental transmission curves and their characteristics are ussed. The measured mixer performance is compared with ry for operation in the frequency range 240 to 840 Mc/s. It is m that the transition speed of the superconducting thin films be determined and that film-switching times are at least as t as 0.625 nsec.

6194 THRESHOLD PHENOMENA IN SUPERCONDUCTORS. V.L.Pokrovskii.
ksper. teor. Fiz. (USSR), Vol. 40, No. 1, 143-51 (Jan., 1961).
ussian.
Decay thresholds of elementary excitations are established solute zero. It is shown that ultrasonic waves in a supeructor are not absorbed up to the threshold frequency $\omega_t = 2\Delta$; e threshold point the absorption jumps abruptly to a finite e $\sim 10^{-2}\ \omega_t$. Processes of sound emission and electron–hole production are considered. The relative role of these esses is clarified for various electron energies. [English slation in: Soviet Physics–JETP (USA), Vol. 13, No. 1, 100-4 y, 1961)].

16195 INFLUENCE OF QUASIPARTICLE DAMPING ON THE PROPERTIES OF A SUPERCONDUCTOR.
etbeder-Matibet and P.Nozières.
. Acad. Sci. (France), Vol. 252, No. 25, 3943-5 (June 19, 1961).
rench.
The method of Green functions is used to calculate the condition superconductivity at zero temperature when the quasiparticles damped. It is found that quasiparticles contribute to the nation of an energy gap if and only if their excitation energies greater than their widths. It is asserted that the damping has e effect in practice. D.J.Thouless

16196 QUANTIZATION OF FLUX IN A SUPERCONDUCTING CYLINDER. J.Bardeen.
s. Rev. Letters (USA), Vol. 7, No. 5, 162-3 (Sept. 1, 1961).
Using the Gor'kov formulation (Abstr. 10836 of 1960) of the zburg–Landau theory, the flux in a thin superconducting nder, of radius r and thickness d, is shown to be quantized in s of $(hc/2e)[1 + (2\lambda^2/rd)]^{-1}$, where λ is the penetration depth, $d < \sim 2\lambda$, in the region close to the transition temperature. also following abstract. G.E.Murphy

16197 QUANTIZATION OF THE FLUXOID IN SUPERCONDUCTIVITY. J.B.Keller and B.Zumino.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 164-5 (Sept. 1, 1961).
It is shown that the fluxoid through any closed curve in a superconductor is quantized in units of $\pi\hbar c/e$; Bardeen's result (see preceding abstract) for the flux in a thin superconducting cylinder is verified. G.E.Murphy

16198 RELATION BETWEEN DEPTH OF PENETRATION OF A MAGNETIC FIELD AND TEMPERATURE IN SUPERCONDUCTING LEAD. E.Shimashek.
Acta phys. Polon. (Poland), Vol. 20, No. 7, 563-5 (1961).
In Russian.
Using his own measurements of the critical magnetic fields for thin films of lead, the author plots a graph connecting δ, the depth of penetration, and $\Delta T = T_K - T$, where T is the actual and T_K the critical temperature. This graph nearly coincides with the one representing Gorter and Casimir's equation $\delta = \delta_0\{1 - (T/T_K)^4\}^{-1/2}$. The value of the constant δ_0, which is the value of δ at 0°K, was found by extrapolation. It agrees with the values of other workers. N.Davy

16199 A STUDY OF SUPERCONDUCTING NIOBIUM BY ELECTRON TUNNELLING. P.Townsend and J.Sutton.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 309-11 (Aug., 1961).
Tunnelling measurements are reported on Nb–NbO–Pb sandwiches as a function of temperature and magnetic field, using oxidized Nb strips with Pb evaporated on. R.G.Chambers

16200 THE EFFECTS OF IMPERFECTIONS ON THE SUPERCONDUCTING CRITICAL TEMPERATURE OF TANTALUM. D.P.Seraphim, D.T.Novick and J.I.Budnick.
Acta metallurgica (Internat.), Vol. 9, No. 5, 446-52 (May, 1961).
The critical temperature decreases with increasing concentration of nitrogen, oxygen or hydrogen. The magnitude of the effect may be correlated with the residual resistivity and thus may be interpreted as being primarily a mean free path effect; just as has been found previously in substitutional solid solutions. Experiments with cold worked tantalum indicate, however, that both the nature as well as the number of the defects which scatter the normal state electrons are of importance, since no significant changes in T_c was found in spite of the fact that the mean free path was decreased by an order of magnitude due to cold work.

16201 THERMAL CONDUCTION IN NORMAL AND SUPERCONDUCTING TIN AND INDIUM. A.M.Guénault.
Proc. Roy. Soc. A (GB), Vol. 262, 420-34 (July 18, 1961).
A study of the thermal conductivity of single crystal specimens of pure tin and indium was made in the temperature range 2 to 4.2°K in both the normal and superconducting states. Values of the normal state thermal conductivity, corrected for magnetoresistance, fitted well the expression $1/K = \alpha T^2 + \beta/T$, although deviations from this formula were observed in the purest specimens. Serious departures from Matthiessen's rule occurred, however, in that the magnitude of the lattice resistance (αT^2) depended strongly on purity. Systematic variations in the ratio of conductivities K_S/K_N with purity were found to follow the simple expression suggested by Hulm. The limiting curves for K_S/K_N (in the cases of all impurity scattering, and of all lattice scattering of electrons) are compared with recent calculations on the Bardeen–Cooper–Schrieffer thoery of superconductivity.

16202 MAGNETIC PROPERTIES OF THIN SUPERCONDUCTING TIN AND INDIUM FILMS. B.K.Sevast'yanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 52-63 (Jan., 1961).
In Russian.
The conditions under which there is no normal phase in a finite size superconducting film placed at a small angle to a uniform magnetic field are determined. The torques acting on such a film are measured. The dependence of the transverse component of the magnetic moment on temperature and thickness is determined for tin and indium films 4×10^{-3} to 2×10^{-6} cm thick. The critical field values derived from these measurements are analysed. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 1, 35-42 (July, 1961)].

ULTRASONIC ATTENUATION IN TIN SINGLE CRYSTALS IN SUPERCONDUCTING STATE. See Abstr. 14173

RAMAN SCATTERING OF LIGHT IN SUPERCONDUCTORS. See Abstr. 14614

RECENT DEVELOPMENTS IN HIGH SPEED SUPERCONDUCTING DEVICES. See Abstr. 16220

SUPERCONDUCTOR DEVICES FOR USE IN COMPUTERS. See Abstr. 16219

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

16203 FOUR-PROBE RESISTIVITY MEASUREMENTS ON SMALL CIRCULAR SPECIMENS. D.E.Vaughan.
Brit. J. appl. Phys., Vol. 12, No. 8, 414-16 (Aug., 1961).

General formulae are presented for square and linear probe arrays on circular specimens which permit the calculation of sheet resistivity from voltage and current measurements made with the probes in any position. From these formulae it is deduced that the square probe array is preferable on small specimens on the grounds of accuracy, as well as from spatial considerations.

16204 MEASUREMENT OF ELECTRICAL RESISTIVITY BY A MUTUAL INDUCTANCE METHOD.
R.G.Chambers and J.G.Park.
Brit. J. appl. Phys., Vol. 12, No. 9, 507-10 (Sept., 1961).

The resistivity of a sample can be deduced from the change in mutual inductance between two coils when the sample is inserted. It is shown that with simple equipment for measuring mutual inductance over a range of frequencies, the method can be used to measure resistivities from 2×10^{-9} ohm cm upwards, and the necessary functions are tabulated.

16205 TECHNIQUE FOR MEASURING HIGH ELECTRICAL RESISTANCES BY MEANS OF AN IONIZATION CHAMBER. D.Blanc, E.Fort, R.Lacoste and J.Lagasse.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 35A-38A (Feb., 1961). In French.

An ionization chamber acting as a current source allows accurate measurements of high electrical resistances. In the simplest method, the voltage applied to the whole circuit is maintained constant. The measurements are limited to resistances, the values of which are small as compared to the internal resistance of the chamber: with an internal resistance of 10^{16} ohms, the limit is near 4×10^{14} ohms. To keep the voltage constant between the electrodes of the chamber, by a method of compensation, is more useful; a reduction of the current crossing the chamber is not important; the only practical limit lies in the maximum voltage that the resistance being measured can support, this maximum voltage being imposed by the current supplied by the source. The method has been used to study various thin dielectrics sheets, particularly micas.

16206 ELECTRICAL RESISTIVITIES OF METALS BY THE METHOD OF MAGNETIC DAMPING. K.D.Baveja.
J. sci. industr. Res. (India), Vol. 20B, No. 7, 343-5 (July, 1961).

The electrical resistivity of a metallic plate, oscillating in a uniform magnetic field, is deduced assuming a definite distribution of the induced currents. The resistivity is expressed in terms of the coefficient of magnetic damping, the intensity of the magnetic field and the dimensions of the metallic plate. The assumption of the particular distribution of the induced currents is verified experimentally by measuring the electrical resistivity by this method for specimens of different materials.

16207 AUTOMATIC CONDUCTIVITY PLOTTING MACHINE. J.J.Tiemann.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1093-7 (Oct., 1961).

A system diagram and the circuit for each of the components of an automatic conductance plotting machine are presented. Conventional circuitry using vacuum tubes is used throughout. The circuit impresses a small 5 kc/s incremental voltage of controlled amplitude upon the d.c. bias of the diode under test and senses the magnitude and sign of the in-phase component of the resulting current.

16208 DESIGN OF WIDE-BAND SHIELDED TOROIDAL R TRANSFORMERS. R.S.Berg and B.Howland.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 864-5 (July, 1961).

Wide-band transformers that cover 1-100 Mc/s wound on toroidal cones are described. The eddy current shield is a co plated layer on the cone. D

16209 ELECTRICAL-RESISTIVITY METER MONITORS OXYGEN CONTENT OF LIQUID METALS.
L.R.Blake and A.R.Eames.
Nucleonics (USA), Vol. 19, No. 5, 66, 68, 70, 72 (May, 1961).

Liquid metal is circulated through a toroidal pipe that for the secondary load of a transformer with a double-loop magne core. The voltage required to drive a current round the toroi measured with a probe coil. A high temperature-coefficient resistance in thermal contact with the toroid compensates for temperature changes. Resistivity changes of 1 part in 10^4 corresponding to oxygen concentrations in sodium of 1 p.p.m be measured. R.D.

16210 TRANSISTOR CURRENT STABILIZERS FOR MED POWER ELECTRONMAGNETS (1-10 kW).
M.Sauzade.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 161 A-170 A (Nov., 1960). In French.

After outlining the general principle of high power stabili supply for electromagnets, the author gives the expressions required for computing the essential characteristics. An appr mate computation of the feedbackloop gain allows one to find t condition of stability. Various methods are used to measure t degree of magnetic field stability.

16211 PASSIVE STABILIZERS OF VOLTAGE AND CURR IN BRIDGE FORM. A.Caravel.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 187 A-190 A (Nov., 1960). In French.

The use of a stabilizing Zener diode leaves a slight variat of the output voltage when the input voltage varies. To suppre this residual effect the diode is introduced into a Wheatstone bridge as one of the arms and the bridge dynamically balanced A careful choice of the elements gives a small output-resistan The anode current of a pentode can be regulated by the same means.

16212 STABILIZATION OF THE OUTPUT VOLTAGE OF ALTERNATOR BY AN ELECTRONIC METHOD.
A.Pagani.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 204A-206A 1960). In French.

Description of an electronic device for stabilizing the out voltage of an alternator feeding a double-polarity 50 kV gener for a corpuscular microscope. The stability of the device is s by means of a Bode diagram and the introduction of a notching circuit permits a high gain to be maintained at low frequencies avoiding troublesome oscillations.

16213 IMPROVED MICROFURNACE POWER SUPPLY.
J.H.Welch.
J. sci. Instrum. (GB), Vol. 38, No. 10, 402-3 (Oct., 1961).

A previously described hot-stage device for high-tempera microscopy (Abstr. 884 of 1955), in which specimens are supp by a thermocouple used both for heating and temperature mea ment, uses a high-speed switch to interrupt the heating curre intervals during which temperature measurement takes place. Interruption of the heating current by silicon rectifiers minim maintenance problems and inaccuracies of temperature measu ment which may arise with mechanical switching. Precaution avoiding other sources of inaccuracy in temperature measure are also described.

16214 STABILIZED POWER SUPPLY FOR MICROCALO METRY. J.D.Hill and E.A.Steer.
J. sci. Instrum. (GB), Vol. 38, No. 10, 411-12 (Oct., 1961).

It is pointed out that the power match occurring when sou and load resistances are equal can be used to stabilize the po developed in the specimen heater; as an aid in "adiabatic" calorimetry.

15 AIRCRAFT INSTRUMENT FOR MEASURING THE CHARGE ON PARTICLES OF PRECIPITATION.
M. ianitov and V.V.Mikhailovskaya.
ri y i Tekh.Eksper. (USSR), 1958, No. 2, 86-9 (March-April).
R sian.
ie equipment described in considerable detail in this article
b cally a pulse electrometer capable of measuring charges, in
e nge ±5 × 10^{-4} to ± 1.0 c.g.s. units, on precipitation particles
o nder cloud. The charge is measured inductively as the
r .es pass through a metal ring mounted above the nose of the
s e where the disturbance of the true air speed does not exceed
fe ercent of the aircraft speed. The dimensions of the ring are
o with special care to give the necessary sensitivity
d gh resolution. A circuitry diagram is given and details of its
r rmance, and also the methods of calibration. The apparatus
s en used in aircraft for more than 40 hours, including a
r of 3 hours continuous operation: it can work at temperatures
o -30°C to +25°C. [English translation in: Instrum. exper. Tech.
S No. 2, 273-8 (March-April, 1958; publ. April, 1959)].
J.M.Stagg

16 DESCRIPTION OF A SUPPLY FOR AN IONIZATION GAUGE WITH LOGARITHMIC SENSITIVITY.
A enucci.
l s. Radium (France), Vol. 21, Suppl. No. 11, 219A-222A
o 1960). In French.
supply for an ionization gauge of the normalized triode type
c cribed. The electronic grid current is pre-regulated and
a zed. The pressure is directly read on a single measuring
i ammeter, in a single range from 5 × 10^{-4} to 5 × 10^{-7} mm Hg.
w to a simple electronic device, the current passing through
e easuring microammeter, is proportional to ionic current
l ted by the gauge plate. In these conditions, the relative accur-
y measurement remains constant throughout the useful range.

17 REGULATED SUPPLY FOR ELECTRONIC FLASH TUBES. J.Milliard.
7s. Radium (France), Vol. 22, Suppl. No. 6, 139A-140A
u . 1961). In French.
. simple variable voltage power supply to charge a flash tube
itor is described. D.Walsh

218 TRANSMISSION-TYPE PIEZOELECTRICITY DETECTOR. R.J.Blume.
sci. Instrum. (USA), Vol. 32, No. 5, 598-9 (May, 1961).
. circuit for testing small crystal samples to determine if the
alline material is piezoelectric is described. The circuit
sts of a radio-frequency signal source frequency-modulated at
s feeding, through two capacitors, two nearly identical diode
tor circuits, which in turn drive a differential oscilloscope.
f the two capacitors is the crystal and its holder; the other is
my. When the centre frequency of the frequency-modulated
put is tuned to a piezoelectric resonance, the resulting
ance between the outputs of the two detectors produces an
stakable indication on the oscilloscope trace. The circuit is
tive enough to give adequate indications on samples roughly
mm on an edge. J.M.Taylor

MULTI-STAGE AMPLIFIER FOR A HOT-WIRE ANEMOMETER.
Abstr. 15931

SYNCHRONOUS DETECTOR USING THE 7360 BEAM-DEFLECTION TUBE. See Abstr. 16609

219 SUMMARIZED PROCEEDINGS OF A SYMPOSIUM ON ELECTRONIC DEVICES AT HELIUM TEMPERATURES
ONDON, NOVEMBER, 1960. D.H.Parkinson.
J. appl. Phys., Vol. 12, No. 8, 353-8 (Aug., 1961).
A one-day symposium (8 papers) on electronic devices which
. at helium temperatures was held jointly by the Low Tem-
ture Group and the Electronics Group of The Institute of Physics
The Physical Society on 15 Nov., 1960. The emphasis was on
ces which could be used in electronic computers. Recently
e have been considerable advances in the research on Crowe
and cryotrons. Both devices can be switched at high speed
0-15 nsec) and the factors governing their performance are
y well understood. There have been equal advances in the
lopment of a helium refrigerator of great reliability and
iency. With cryotrons, the conditions for reproducibility are
ess stringent than with the Crowe cell and, as four terminal
ces with current gain, they offer great flexibility to computer designers, being capable of use both in the store and in logical components. The p–n junction, tunnel diode, and cryosar are all based on semiconductors and all work at helium temperatures. They could be very useful ancillary devices in computers based on superconductors or, on the other hand, computers could be based on these devices entirely and the use of liquid helium would then be unnecessary. However, taking into account the low heat dissipation and close packing feasible with superconductive devices (10^9 bits in a 35 cm cube), where fast computing is concerned the cryotron offers great advantages. It is, moreover, a device of universal application throughout a computer which may demand a new approach to logical design and the layout of the machine. See also two following abstracts.

16220 RECENT DEVELOPMENTS IN HIGH SPEED SUPERCONDUCTING DEVICES. D.R.Young.
Brit. J. appl. Phys., Vol. 12, No. 8, 359-62 (Aug., 1961).
The factors controlling the speed of useful cryotron circuits are: circuit geometry, insulation thickness, resistivity of superconducting film in normal state, superconducting and transition properties of films used. These factors are discussed in detail and in addition new circuit techniques are described that increase the speed of operation to the millimicrosecond range. A new type of cryotron is mentioned that introduces a significantly larger resistance in the normal state. This device is particularly useful for driving long lines such as encountered in cryogenic memory planes.

16221 P–N JUNCTIONS AT VERY LOW TEMPERATURES. A.K.Jonscher.
Brit. J. appl. Phys., Vol. 12, No. 8, 363-71 (Aug., 1961).
This paper gives a brief review of those low temperature properties of silicon and germanium which are relevant to the performance of p–n junctions at liquid helium temperatures. Experimental results are presented for germanium and silicon diodes and their interpretation is attempted. It is found that germanium devices behave in a manner similar to room temperature behaviour provided the ohmic contacts are adequate. Silicon diodes exhibit anomalies owing to insufficient doping of the end regions or to trapping in the base.

16222 SEVERAL ASPECTS OF THE APPLICATION OF THE MATRIX CALCULUS OF NON-LINEAR CIRCUITS TO LOCAL OSCILLATIONS. F.Bertein.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 137A-148A (Nov., 1960). In French.
General principles are surveyed about matrix calculus applied to the above mentioned circuits. This method leads occasionally to the description of currents not by their various components, but by amplitude and phase modulations. Applications are presented concerning problems of oscillator stability.

16223 STUDY OF A DIODE BRIDGE NANOSECOND RESOLUTION COINCIDENCE CIRCUIT.
S.C.Pancholi and N.K.Saha.
Proc. Nat. Inst. Sci. India A, Vol. 27, No.2, 155-60 (March 26, 1961).
Detailed studies are described for different pulse amplitudes and pulse shapes. The shortest resolving time obtained with the circuit is 0·7 nanosecond. The circuit behaves in an extremely stable manner.

16224 A SIMPLE TYPE OF FAST COINCIDENCE CIRCUIT OF MILLIMICROSECOND RESOLUTION.
N.K.Saha and S.C.Pancholi.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 5, 464-8 (Sept. 26, 1960).
A germanium diode bridge fast coincidence circuit is described which gives a prompt resolution time round about 2 × 10^{-9} sec. with β- and γ-ray pulses in trans-stilbene crystals through RCA 5819 photo-multipliers. Effect of phosphor decay time on the resolving time is discussed.

16225 FAST COINCIDENCE CIRCUITS USING TRANSISTORS IN THE AVALANCHE REGION.
J.C.Artiges and J.C.Brun.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 53A-58A (Feb., 1961). In French.
Describes the use of ordinary transistors working with delayed collector conduction (avalanche) in fast-trigger circuits (rise-time 10^{-9} sec) and fast coincidence circuits built with this element. The study of this circuit with: (a) a pulse generator; (b) phototube signal; results coincide with those obtained by a whole series of experiments, resolving time reaching 2 × 10^{-9} seconds with 90% efficiency.

MEASUREMENT OF THE TIME DEPENDENCE OF SCINTILLATION INTENSITY BY A DELAYED-COINCIDENCE METHOD.
See Abstr. 13223

16226 TIME-TO-AMPLITUDE CONVERTER OF HIGH RESOLVING POWER.
S.Gorodetzky, R.Richert, R.Manquenouille and A.Knipper.
J. Phys. Radium (France), Vol. 21, No. 5, 388-9 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The resolution curve for Co^{60} gamma rays taken with a fast time-to-amplitude converter shows a full width at half maximum of about 4.10^{-10} sec. The slope at two decades below the maximum is about 4.5×10^{-11}.

16227 MEASURING THE LIFETIMES OF EXCITED STATES BY TIME-AMPLITUDE CONVERSION.
J.Samueli and A.Sarazin.
J. Phys. Radium (France), Vol. 21, No. 5, 390-3 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). A time-to-amplitude converter covering the interval from 0.1 to 10 nsec is described. The resolution for Na^{22} gamma ray annihilation radiation is 0.7 nsec. The system was used to measure the lifetime of the 80 keV gamma transition of I^{131}.

16228 MULTIDIMENSIONAL TRANSFER ANALYSERS.
A.Pages.
J. Phys. Radium (France), Vol. 21, No. 5, 475-7 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Spectrometric analysis depending on several parameters necessitates a large number of experiments and awkward electronic apparatus. To diminish the working time and to increase the stability and the experimental possibilities, the problem of multidimensional analysis is investigated. A double 63 channel analyser is in operation, recording on magnetic tape with the essential advantage of conserving the time parameter. Another one is under construction with 16 or 32 digits, following a transfer circuit rationalization.

16229 AIMA-2 PULSE-HEIGHT ANALYSER.
M.V.Pasechnŷk, R.H.Ofenhenden and L.D.Konenko.
Ukrayin. fiz. Zh. (USSR), Vol. 4, No. 1, 57-71 (1959). In Ukrainian.

Description of the principal circuitry. Discrimination of pulses is effected by amplitude-time transformation. The pulses in each channel are stored on a magnetic drum. Measured data are represented on a double-beam c.r.t. on both a binary and a linear scale. The specifications of the instrument are: number of channels - 50 or 80; capacity of each channel when operating on 50 channels - 65 535 pulses; resolving time - 1.3 msec; maximum loading of analyser - 5000 pulses per second. The instrument is capable of analysing only such pulses as coincide in time with the driving pulse. The instrument consists of two units (a measuring and a power unit), each of which is of the size of a table oscillograph.

16230 TRANSISTORIZED PULSE HEIGHT INDICATOR.
U.Galil and D.Ophir.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 2, 197-201 (1960).

The apparatus presents a simple method using transistorized circuitry for the numerical indication of data obtained from cosmic ray detectors. The method is applicable to the indication of any pulse height by converting amplitude levels to pulse counts.

ELECTROSTATICS . DIELECTRIC

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

16231 A METHOD FOR THE DETERMINATION OF DIELECTRIC CONSTANTS OF SINGLE CRYSTALS
V.H.F. R.A.Padmanaban.
J. sci. industr. Res. (India), Vol. 20B, No. 7, 303-6 (July, 1961)

Describes a technique for measuring dielectric constants single crystals at very high frequencies (50-300 Mc/s) using a micrometer electrode system. A suitable dielectric sample hold designed to minimize the errors due to edge effects. The elec measurements were carried out with the help of an admittance meter. The experimental arrangement gives an accuracy of a 5% for values of the dielectric constant, depending upon the sin nature of the dielectric used.

16232 MEASUREMENT OF THE DIELECTRIC CONSTAN FILAMENT NYLON IN A TRANSVERSE FIELD.
F.S.Ward.
Brit. J. appl. Phys., Vol. 12, No. 9, 450-5 (Sept., 1961).

An instrument was designed for measuring the dielectric constant of a material in the form of a single cylindrical filam and experiments are described in which it is used for measure on nylon. The filament is placed centrally between two silvere optical flats, which form a parallel-plate capacitor and serve the tuning capacitor of a radio-frequency oscillator. Accordin an existing theory, the change in capacity due to the presence dielectric is given by:

$$\delta C = \left(\frac{b^2 H}{2D^2} \tanh\frac{\pi B}{2D}\right)\Big/\left(\frac{\epsilon + 1}{\epsilon - 1} - \frac{\pi^2 b^2}{3D^2}\right)$$

(where b is the radius of the filament, H the length of the capa B the width and D the distance between the plates) and δC can determined from the corresponding change in oscillator freque if the electrical parameters of the circuit are known. The exp mental observations confirmed the general form of the equatio they were not sufficiently accurate to verify the second-order $\pi^2 b^2/3D^2$. A value of 3.0 was found for the dielectric constant nylon at 6 to 7 Mc/s, which is in reasonable agreement with va of 3.1 to 3.4 recorded by other workers for both filament and bulk nylon.

16233 ELECTROSTATIC DIPOLE MOMENT OF A DIELECTRIC CUBE. T.W.Edwards and J.Van Bl
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 151-5 (1961).

The electrostatic dipole moment of a dielectric cube intro into a uniform electrostatic field can be determined by solving appropriate surface integral equation. High-speed digital com were employed to solve the matrix approximation to this equa

16234 ON A NEW TYPE OF CONDENSER FOR MEASURI THE DIELECTRIC PERMITTIVITY OF SOLIDS BY METHOD OF IMMERSION. T.Piech.
Acta phys. Polon. (Poland), Vol. 20, No. 1, 93-5 (1961).

A test call is described which enables measurements of th permittivity of the pure liquid and of the mixture of solid and liquid to be carried out with one filling. It has the advantage t any solubility of the solid in the liquid can be taken into accou
K.W.Ple

16235 AN INTERFEROMETRIC METHOD FOR DETERM COMPLEX PERMITTIVITY AT MILLIMETRE WA LENGTHS. E.Constant and R. de Wavrechin.
C.R. Acad. Sci. (France), Vol. 252, No. 18, 2690-2 (May 3, 196
In French.

Difficulties which arise in transmission-line technique at millimetre wavelengths are avoided by an optical free-space arrangement. Radiation from a horn is reflected back to a rec by a metal plane, part of which is covered by the liquid sample known variable depth. The theory of the interferometric patte from rays reflected from the covered and uncovered metal is lined for substances of low loss. The method and theory were tested at 35 Gc/s for dilute solutions of polar liquids in non-po solvents. An accuracy of 0.2% was obtained for ϵ', and one of several per cent for ϵ''. The method is rapid and direct, and

epend on the response-law of the detector. All the power of ource is usable. Pre-calibration is necessary, and is effected liquids of known loss. J.Sheridan

ISE AND CALIBRATION OF A "GENERAL-RADIO" ADMITT- METER FOR THE MEASUREMENT OF PERMEABILITY PERMITTIVITY. See Abstr. 16487

236 MEASUREMENT OF THE DIELECTRIC PROPERTIES OF HIGH LOSS SUBSTANCES.
oubert and P.Caillon.
nys. Radium (France), Vol. 21, Suppl. No. 11, 155 A - 160 A ., 1960). In French.
In order to measure the dielectric properties of insulating erials at high frequencies an apparatus was constructed based ie variation of the width of the resonance curve of a tuned uit when an impedance with losses is in circuit. This method easurement was found better than others in certain conditions are defined.

237 ESTIMATING THE ELECTRIC FIELD INSIDE A RECTANGULAR TANK WITH BOUNDARIES AT O POTENTIAL. S.J.Vellenga.
. sci. Res. B (Netherlands), Vol. 9, No. 1, 35-44 (1961).
The maximum field strength occurring in a tank of rectangular ie whose boundaries are at zero potential and which is partially d with a liquid bearing a constant charge density can be kly calculated by means of a strongly convergent series ved in the article. Restrictive assumptions are: (1) the charge omogeneously distributed; (2) the difference in the values of the ectric constant of the vapour and the liquid is ignored; (3) surface of the liquid is parallel to the bottom of the tank.

.6238 THE SURFACE CHARGE OF A SEMI-INFINITE CYLINDER DUE TO AN AXIAL POINT CHARGE.
.Lauwerier.
l. sci. Res. B (Netherlands), Vol. 8, No. 4, 277-89 (1960).
Determines the surface charge density of a semi-infinite ducting cylinder due to an axial point charge. The problem can educed to an integral equation of the Wiener—Hopf type. The vant factorization problem is studied in detail.

6239 FORCES IN DIELECTRIC FLUIDS.
J.D.Horgan and D.L.Edwards.
ppl. Phys. (USA), Vol. 32, No. 9, 1784 (Sept., 1961).
The paper concerns the fountain of dielectric liquid produced highly charged needle conductor immersed in the liquid. erimental work has indicated that the effect is due to ionization he liquid and is not a polarization effect as has been thought. T.C.Toye

6240 FORMATION OF LIQUID JETS IN NONUNIFORM ELECTRIC FIELDS. H.A.Pohl.
ppl. Phys. (USA), Vol. 32, No. 9, 1784-5 (Sept., 1961).
A note on the paper by Horgan and Edwards (preceding abstract) gesting that the fountain effect is a combination of dielectro- resis and electrophoresis. T.C.Toye

.6241 ON SOME DUAL SERIES EQUATIONS AND THEIR APPLICATION TO ELECTROSTATIC PROBLEMS FOR HEROIDAL CAPS. W.D.Collins.
c. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 367-84 (1961).
A particular form of dual series equations is considered. The ution, together with the solutions to certain Legendre polynomials, presented and other equations are then developed and applied to rodynamic and electrostatic problems. The reduction of the ution of the general dual series equations to the solution of a dholm integral equation is presented. C.A.Hogarth

16242 A POSSIBLE EXPLANATION OF THE BRANLY EFFECT. R.Gabillard and L.Raczy.
R. Acad. Sci. (France), Vol. 252, No. 19, 2845-7 (May 8, 1961). French.
Branly's discovery that the reduced resistance of metallic ngs obtained when an electric spark is produced in their vicinity, now explained on a theory based on classical electrostatics and lecular forces of attraction between solid macroscopic particles. ne simple experiments are described in support of the theory. H.H.Hodgson

16243 NOTE ON AN ELECTRIFIED CIRCULAR DISK SITUATED INSIDE AN EARTHED COAXIAL INFINITE HOLLOW CYLINDER. W.D.Collins.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 3, 623-7 (July, 1961).
The method of Copson, based on known solutions of Abel's integral equation for the determination of the surface density of electric charge induced on a thin circular disk maintained at a constant potential in an external electrostatic field, can be extended to determine the surface charge on the disk when situated inside an earthed coaxial infinite hollow cylinder. The problem is not solved in closed form but ultimately by iterative methods. C.A.Hogarth

16244 FIELD STRENGTH DUE TO A PLANE LAYER OF CHARGE DISTRIBUTION. T.Frey.
Periodica polytech., Elect. Engng (Hungary), Vol. 4, No. 4, 327-42 (1960). In German.
The potential field integral of an integrable charge distribution limited by a Jordan curve and of finite thickness is derived. The field distribution inside the layer can be uniquely determined if the charge density satisfies the Dini—Lipschitz conditions (namely the singularity of the charge density distribution on the surface of the layer is x^{-1+d}, where x is the distance from the surface and $d > 0$). In particular, limiting conditions cannot be obtained for a uniform charge density throughout the thickness of the layer. J.K.Skwirzynski

16245 THE DEVELOPMENT OF A HIGH VOLTAGE GENERATOR WITH A CURRENT OF ELECTRIFIED PARTICLES UNDER AN INTERNAL PRESSURE OF 10 kg/cm^2.
Nguyen-Trinh-Dzoanh.
C.R. Acad. Sci. (France), Vol. 252, No. 19, 2836-8 (May 8, 1961). In French.
Brief explanation of the principle enabling the electrical output to be increased by increasing the pressure inside the generator. The output of the machine was restricted by spurious discharges which occurred at the exit of the ionizer. By increasing the pressure, the breakdown field strength was increased in the same ratio as the pressure and the electrical output was increased by the same factor. The best performance was obtained with a gas composition of 10% oxygen and 90% nitrogen. A.E.Kay

INFLUENCE OF DUST DEPOSIT ON THE ELECTRICAL PURIFICATION OF AEROSOLS. See Abstr. 15209

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

16246 EQUATIONS OF POTENTIAL AND TEMPERATURE FOR CONDUCTORS IN A MAGNETIC FIELD. H.Stachowiak.
Acta Phys. Polon.(Poland), Vol. 20, No. 1, 67-75 (1961). In French.
By imposing stationary conditions on the thermodynamic equations for irreversible processes involving thermo-galvano-magnetic effects, equations for potential and temperature are obtained. When the conductor is electrically isolated, a unique solution is obtained when the surface temperature is known. M.A.Taylor

16247 A METHOD OF SOLUTION OF POTENTIAL AND TEMPERATURE EQUATIONS FOR CONDUCTORS IN A MAGNETIC FIELD AND THE UNIQUENESS PROBLEM.
H.Stachowiak.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 11-12, 773-5 (1960).
The equation derived previously (Abstr. 2942 of 1961) is applied to the case of a magnetic field. It is shown that the solution can be divided into two parts: first, with the magnetic field absent, subject to Dirichlet's boundary conditions; second, with the magnetic field present and embodying the first solution. Only linear terms are considered. The transition from the first to the second solution is shown to be unique. J.K.Skwirzynski

16248 ENERGY CONSIDERATIONS IN THE INSTABILITY OF A CURRENT-VORTEX SHEET. D.H.Michael.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 3, 628-37 (July, 1961).

Energy taken into a growing disturbance must be provided from the mean energy stored in the system in its initial state. The Helmholtz instability of a plane inviscid vortex sheet is analysed. Firstly the provision of disturbance kinetic energy by the break-up of the organized motion of the mean stream is examined. Secondly the energy balance of a current-vortex sheet in the non-dissipative case is considered and it is found that when the interface is unstable the overall magnetic energy increases at the expense of the kinetic energy. C.A.Hogarth

16249 ACCURATE LOW LEVEL CURRENT SOURCE. W.K.Brookshier.
Rev. sci. Instrum. (USA), Vol. 32, No. 3, 359-60 (March, 1961).

Currents of down to 10^{-13} A are produced, with an accuracy of ~ 1% and a repeatability of 0.1%, by an integrator comprising an amplifier wih capacitive negative feedback. A fixed current is fed into the virtual earth at the amplifier input, which is chopper-stabilized to better than 1 mV, and a linearly increasing voltage appears at the output. The required output current is obtained by applying the output voltage to a high-quality capacitor, and is equal to the input current multiplied by the ratio of the output/feedback capacitors. The source can be used in conjunction with a suitable electrometer for measuring resistance up to 10^{15} ohm. T.H.D.Attewell

16250 PIEZOELECTRIC GENERATION OF AN ELECTRICAL IMPULSE. M.Redwood.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1386-90 (Oct., 1961).

The following problem is examined theoretically: A pressure is applied to an open-circuited bar of piezoelectric ceramic; after steady-state conditions have been achieved, an electrical resistance R is connected between the electrodes and simultaneously the pressure is removed. General equations describing the subsequent current and energy dissipation in the resistor are developed, and examined in detail for a specific transducer of lead zirconate—titanate ceramic. The general equation for current consists of a series of time-delayed functions, signifying physically that a mechanical wave propagates through the transducer with successive reflections at the end faces, releasing strain energy originally stored in the material; this energy is then dissipated in electrical form in the resistance. The initial current has two components, an exponential function representing the discharge of energy stored in electrical form in the transducer capacitance C_0 (about 10% of the total stored energy), and a step function representing the release of energy stored in mechanical form (remaining 90%). If R is small the exponential function predominates, and has a time constant which is approximately RC_0; the stored electrical energy is released very rapidly, while the mechanical energy is released much more slowly. If R is large (of the order of 10^4 ohms), exponential function and step function are of comparable magnitudes, and the time constant of the exponential is modified by the mechanical impedance of the transducer.

CURRENTS FROM GAMMAS MAKE DETECTORS AND BATTERIES. See Abstr. 13376

NEW, THERMALLY VARIABLE BEAD RESISTOR. See Abstr. 14494

METAL TRANSFER IN ELECTRICAL CONTACTS. See Abstr. 16295

16251 EFFICIENCY OF THERMOELECTRIC DEVICES. E.T.B.Gross.
Amer. J. Phys., Vol. 29, No. 11, 729-31 (Nov., 1961).

The known expressions for the efficiencies of various thermoelectric energy converters can be so modified that the Carnot efficiency η_c of the ideal heat engine cycle appears as one of two significant parameters. The other parameter ZT (Z = figure of merit, T = hot spot temperature in °K) is a significant characteristic of the thermoelectric material used in the device. Using these parameters leads to a realistic evaluation efficiencies possible at present under ideal conditions.

16252 MATHEMATICAL THEORY OF A PELTIER EFFECT REFRIGERATOR AND A THERMOELECTRIC GENERATOR. E.B.Penrod and Cho Yen Ho.
J. Phys. Radium (France), Vol. 21, Suppl. No. 7, 97A-112A (July, 1960). In French.

The equation

$$\frac{d^2\zeta}{d\eta^2} + \alpha\frac{d\zeta}{d\eta} - \gamma\zeta + \rho = 0$$

is derived from fundamental principles of thermodynamics and h transfer, where the coefficients α, β, and γ are ratios that conn four heat power terms. Here heat power transferred to or from the environment is considered as well as the Peltier, Fourier, Thomson, and Joule heat powers. Particular solutions are obtai that show the temperature distribution along the thermocouple arms. From one of the solutions the primary equations of other were developed which are useful in designing Peltier refrigerato and thermoelectric generators and in determining their operatin performances.

IONIZATION

16253 IONIZATION EQUILIBRIUM EQUATION OF STATE. C.A.Rouse.
Astrophys. J. (USA), Vol. 134, No. 2, 435-46 (Sept., 1961).

A complete solution to Saha's equation is obtained for a monatomic gas. The method of solution involves iteration with respect to the electron pressure or electron concentration and c be applied to the simultaneous calculations of any number of ion Some results are given in tabular form.

16254 ON THE BEHAVIOUR OF TUBES OF RARE GASES IONIZED DURING THE PASSAGE OF A SHORT PUL R.Desbrandes, G.Norel and Y.Morineau.
C.R. Acad. Sci. (France), Vol. 252, No. 16, 2393-5 (April 17, 19 In French.

It is observed that the conductivity of an ionized rare gas increases when the anode potential is increased rapidly (rise time less than 3·5 nsec) and that the duration of the state of increased conductivity is proportional to the peak voltage applie For peak voltages ranging from 11 to 50 V. the duration of the s varies from 0·04 to 0·5 nsec. J.L.Red

16255 PROCESSES WHICH TAKE PLACE WHEN BEAMS O HYDROGEN IONS OR ATOMS PASS THROUGH GASE G.Semenescu.
Stud. Cercetari Fiz. (Roumania), Vol. 11, No. 1, 197-209 (1960). In Roumanian.

16256 A MASS SPECTROMETER FOR IONIZATION EFFICIENCY STUDIES USING AN ELECTRON VELOCITY SELECTOR. P.Marmet and J.D.Morrison.
J. chem. Phys. (USA), Vol. 35, No. 2, 746-7 (Aug., 1961).

Using an electron velocity selector of a type previously described (Abstr. 10949 of 1960), curves of ionization efficiency for Ne^+ and A^+ were obtained as a function of electron energy above threshold (0 to 0.4 eV); from the sharpness of the breaks in thes curves it is concluded that the energy spread obtained is about 0.03 eV half-width, or less. J.Du

16257 IONIZATION CROSS SECTIONS NEAR THRESHOLD ELECTRON IMPACT. R.E.Fox.
J. chem. Phys. (USA), Vol. 35, No. 4, 1379-82 (Oct., 1961).

Ionization curves near threshold were taken with a mass spectrometer employing a monoenergetic electron beam. These curves were fitted to previously published data from total ionization experiments in order to obtain absolute cross section for the threshold energy region. Curves for helium, neon, argon mercury, carbon monoxide, and nitrogen are given.

16258 TOTAL IONIZATION IN GASES BY HIGH-ENERGY PARTICLES: AN APPRAISAL OF OUR UNDERSTANDING. R.L.Platzman.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 10, No. 2-3, 116-27 (April, 1961).

Recent years have seen substantial progress in the reliabili and accuracy of the experimental measurements of W, the mean energy required to form an ion pair by the absorption of high-energ radiations (such as α-particles or β-particles) in gases. In ma

s — and especially, but not exclusively, in contaminated gases
gaseous mixtures — the experiments do not determine the
ber of ions produced directly by the incident radiation and the
ndary electrons which it generates, because ion collection is
er than many varieties of secondary process. Thus the total
zation may be augmented by ion-producing collisions of excited
ns (particularly atoms in metastable excited states) or sub-
tation electrons. Use of high-energy radiations therefore
ds valuable opportunities for the study of such processes.
n the various artifacts have been disentangles from the "direct"
zation, the true value of W is available for theoretical analysis.
e different methods for theoretical calculation of W are out-
d, and all are applied to the case of helium. Application of the
ries together with experimental data to other gases and to
ous mixtures yields new information on cross-sections for
astic collisions of charged particles with atoms and molecules,
even on an important optical property of the medium. The
ries also provide the first trustworthy information on the total
bers of various products formed in the absorption of high-energy
ations.

16259 PROBABILITY OF IONIZATION BY THE TRANSFER OF THE ENERGY OF EXCITED ATOMS TO MOLECULES.
.Platzman.
hys. Radium (France), Vol. 21, No. 12, 853-8 (Dec., 1960).
rench.

The probability that a molecule is ionized when it acquires excitation energy in excess of its ionization potential in a collision with etastable helium, neon, or argon atom is deduced for fourteen omic and polyatomic molecules from measurements of the total zation by alpha-particles in noble gases containing these molecules as impurities. In every case this ionization efficiency is ller than unity, and sometimes it is much smaller. In a few inces the results can be compared with the corresponding probabes in excitation by absorption of light, and the two ionization ciencies are found to be equal, within the uncertainties of the . Some of the implications of these results are discussed.

16260 CONSIDERATION OF EXCHANGE IN IONIZATION.
R.Peterkop.
v. PSR Zinat. Akad. Vestis (USSR), No. 12 (161), 57-60 (1960).
tussian.

It is shown that the effect of exchange in the ionization of rogen by electron impact reduces to an interference term in formula for the total cross-section. Criticism and improveits of previous work are given. The wave-function of the process reated by using a phase distortion quantity for the scattered ctron. F.Herbut

16261 ON THE VALIDITY OF TWO CONJECTURES RELATING TO RESONANCE COLLISIONS. B.G.Skinner.
c. Phys. Soc. (GB), Vol. 77, Pt 2, 551-3 (Feb., 1961).

In the theory of resonance collisions a knowledge of $|c_2(\infty)|^2$ is uired, given the first-order coupled differential equations

$$\dot{c}_1 = i f(t)\, e^{-i\alpha t} c_2, \quad \dot{c}_2 = i f(t)\, e^{i\alpha t} c_1$$

h initial conditions $|c_1(-\infty)| = 1$, $c_2(-\infty) = 0$. By numerical gration of the equations on a DEUCE computer, it is shown that expression for $|c_2(\infty)|^2$ of Rosen and Zener (Abstr. 3575 of 1932) a good approximation when $\alpha < \sim \frac{1}{2}$, while that of Gurnee and gee (Abstr. 7987 of 1957) is valid only over a much smaller ge. J.Dutton

16262 CONSIDERATION OF EXCHANGE IN IONIZATION.
R.Peterkop.
c. Phys. Soc. (GB), Vol. 77, Pt 6, 1220-2 (June, 1961).

The effect of exchange on ionization of atoms by electron act is examined. The usual final expression for the cross-tion for n-fold ionization should be multiplied by $[(n+1)!]^{-1}$. rrections are made to Geltman's results on ionization of H str. 3922 of 1956) and of H^- (Abstr. 7077 of 1960). [The conding remark on H^- is in error; the cross-section without change is approximately equal to that including exchange.] M.R.C.McDowell

16263 ELECTRON ENERGY DISTRIBUTION DURING THE PHOTOIONIZATION OF AROMATIC AMINES IN THE SEOUS PHASE.
I.Vilesov, B.L.Kurbatov and A.N.Terenin.
kl. Akad. Nauk SSSR, Vol. 138, No. 6, 1329-32 (June 21, 1961).
Russian.

Experiments were made to verify the hypothesis (Abstr. 17028, 19718 of 1960) that in molecular crystals the fundamental part of the energy loss of the photon occurs in the molecule itself, rather than during the movement of photoelectrons inside the crystals, or upon the excitation of excitons. The distribution of electrons was determined for the photoionization of benzene, aniline, methylaniline and dimethylaniline in the gaseous phase at 5×10^{-3} to 1×10^{-3} mm Hg. The method used was that of the stopping field in a cylindrical condenser. The results are given a tentative interpretation. [English translation in: Soviet Physics—Doklady (USA)]. F.Lachman

16264 MEASUREMENT OF IONIZATION AND ATTACHMENT COEFFICIENTS IN CARBON MONOXIDE IN UNIFORM FIELDS. M.S.Bhalla and J.D.Craggs.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 438-47 (Sept., 1961).

Measurements of pre-breakdown currents in uniform field conditions, in carbon monoxide at different pressures, in the E/p range of 36 to 200 V cm^{-1} (mm Hg)$^{-1}$, indicate the presence of electron attachment. It is suggested that the mechanism of negative ion formation is due to dissociative attachment, therefore values of α and the dimensionally equivalent attachment coefficient η are computed from the semi-logarithmic plots of current against electrode separation, by employing the modified Townsend equation for the growth of current. Static breakdown potentials were measured up to pd ~ 1050 mm Hg cm (where p is the pressure and d the gap length) and show that Paschen's law is obeyed. Further, the values of secondary coefficient γ are computed from upcurving of the semi-logarithmic plots of current against electrode separation. The values of breakdown potential calculated from the breakdown criterion are in good agreement with the measured values, showing that the static breakdown in carbon monoxide is brought about by the Townsend build-up mechanism. The mean cross-sections for ionization and attachment are calculated for various electron mean energies from the mean values of α/p and η/p obtained from the present study and compared with the values computed from low pressure single collision data, by assuming either a Maxwellian or a Druyvesteyn distribution of electron energies. It is concluded that the Maxwellian distribution is satisfactory to explain the results but the Druyvesteyn distribution does not seem to apply. Calculations show that the electron attachment observed in this study is due to resonant attachment processes occurring at about 10 eV and the contributions due to processes of a continuous nature at about 21 and 23 eV are negligible.

16265 EFFECT OF COLLISIONAL ENERGY LOSS ON IONIZATION GROWTH IN H_2.
L.D.Pearlstein and G.W.Stuart.
Phys. of Fluids (USA), Vol. 4, No. 10, 1293-7 (Oct., 1961).

A model is studied for the growth of ionization in H_2 gas with a constant electric field. The model includes a feature which stipulates that an electron loses a fixed energy per collision with an H_2 molecule, independent of the electron energy. Exact solutions are obtained for the time-growing part of the electron distribution function, averaged over velocity orientation, for the case that zero-energy electrons are uniformly supplied through all space at time zero. It is argued that this model provides a reasonable description of physical reality for $E/P > \sim 200$.

16266 DISSOCIATION OF MOLECULAR HYDROGEN IONS IN COLLISIONS WITH GAS MOLECULES.
L.I.Pivovar, V.M.Tubaev and M.T.Novikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 34-9 (Jan., 1961).
In Russian.

The cross-sections for the dissociation of molecular hydrogen ions (H_2^+) in single collisions with H_2 and N_2 molecules and with He, A and Kr atoms are measured at energies from 200 to 1200 keV. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 23-6 (July, 1961)].

16267 DISSOCIATION OF H_2^+ IONS BY A MAGNETIC FIELD.
S.Kaplan, G.A.Paulikas and R.V.Pyle.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 96-7 (Aug. 1, 1961).

H_2^+ ions formed directly in an ion source or by break-up of H_3^+ were accelerated to 20 MeV and dissociated by a magnetic field. The dissociation fraction observed for ions formed from H_3^+ agrees well with that reported by Riviere and Sweetman (Abstr. 2947 of 1961) for electric field dissociation. No evidence for dissociation of directly formed H_2^+ ions was obtained. M.R.C.McDowell

16268 COMPARISON OF THE IONIZATION PRODUCED IN AIR BY ALPHA PARTICLES NEAR 5 MeV AND BY BETA PARTICLES. Z.Bay and P.A.Newman.
Radiation Research (USA), Vol. 14, No. 5, 566-72 (May, 1961).

The average energy expended in producing an ion pair in air was measured for β-particles of S^{35} (average energy ~ 50 keV) and for α-particles of Po^{210} (energy 5.3054 MeV) and found to be $W_\beta = 33.7 \pm 0.3$ eV/ion pair, $W_\alpha = 34.97 \pm 0.07$ eV/ion pair. These measurements confirm the findings of previous investigators that $W\alpha$ in air is definitely larger than $W\beta$. Details of the experimental procedure are given and of correctives applied to the measurements.
B.Brown

16269 FORMATION OF SLOW NEGATIVE IONS IN SINGLE COLLISIONS BETWEEN FAST NEGATIVE HYDROGEN AND OXYGEN IONS AND GAS MOLECULES.
Ya.M.Fogel', A.G.Koval' and Yu.Z.Levchenko.
Zh.eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 13-22 (Jan., 1961). In Russian.

The total cross-sections for the formation of negative ions were measured for single collisions between H^- and O^- ions and O_2, CCl_4 and SF_6 molecules in the energy range from 10 to 50 keV. The slow negative and positive ions formed when H^- and O^- ions pass through these gases were analysed by a mass-spectrometric technique. An analysis was also made of the negative ions formed in collisions between O^- ions and H_2O and CO_2 molecules. The experimental data for ion collisions are compared with the corresponding data for electron collisions. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 1, 8-14 (July, 1961)].

16270 INVESTIGATION WITH A PHOTOMULTIPLIER OF THE ELECTRON COMPONENTS OF SINGLE AVALANCHES. U.Dibbern.
Z. Phys. (Germany), Vol. 163, No. 5, 582-93 (1961). In German.

With a photomultiplier single electron avalanches of 10^3 carriers can be observed in nitrogen. 2.5% of all photons (in the range $3000 \leq \lambda \leq 7000$ A) of an avalanche produce a photoelectron at the cathode. The influence of the variable solid angle on the photomultiplier pulse is given. Noise disturbance is calculated and it is shown that the information depends on the number of photoelectrons only. The electron components of avalanches in methane, nitrogen, and mixtures have an exponential rise with time and the measured time constant τ_{beob} agrees with the theoretical value $1/\alpha v_-$. For carrier numbers $>10^6$ space charge influence is observed, as given by theory. The quantum efficiency Q per ionizing impact is found to be $Q \sim 10^{-3}$ in vapours and $Q \sim 1$ in gases. Values of the electron drift velocity in mixtures of N_2 and CH_4 are given.

IONIZED-GAS FLOW IN FLAMES. See Abstr. 16157

16271 CALCULATED ELECTRON MOBILITY IN HYDROGEN. A.E.D.Heylen.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 779-82 (Nov., 1960).

On the assumption that the electrons have a Maxwellian energy distribution, an expression for their mobility in hydrogen is obtained, by inserting empirical expressions for the elastic collision cross-section and mean electron energy in the general expression for mobility given by Allis [Handbuch der Physik. Vol. 21. Berlin: Springer-Verlag (1956)].
J.Dutton

16272 THE DEPENDENCE OF ELECTRON MOBILITY ON TEMPERATURE IN MERCURY. H.Burck.
Beitr. Plasma Physik (Germany), Vol. 1, No. 2, 82-93 (1960-61). In German.

From measurements in high pressure mercury lamp discharges of current density, voltage gradient and electron concentration (from line broadening) values of electron mobility were determined. With measured temperature values it is found that the mobility is strongly dependent upon temperature. Calculations of the mean free path from Langevin's formula show a similar strong temperature dependence. Calculations are given of the mean free path determined from the gas kinetic cross-section, the Gvosdover cross-section and the cross-section for electron interaction with excited and meta-stable states. It is found that this latter cross-section is important in producing the temperature dependence, and gives reasonably effectively the excitation voltage of the lower Hg levels.
H.Edels

16273 THE EFFECT OF LIGHT ON THE MOBILITY AND CONCENTRATION OF LARGE IONS IN AIR MIXED WITH N_2O GAS. A.F.El Nadi and N.Farag.
J. atmos. terrest. Phys. (GB), Vol. 22, No. 1, 23-31 (Sept., 1961)

During the investigation the action of light of a tungsten fila lamp on a mixture of air and N_2O gas, the following effects were observed: (1) The disappearance of some large ion groups whic appear clearly when the mixture is kept in the dark; (2) A decre in the concentration of ions with mobilities > about $0{\cdot}70 \times 10^{-4}$ and an increase in the concentration of ions with mobilities < about $0{\cdot}70 \times 10^{-4}$; (3) A decrease in the total ion concentratio of the ions with mobilities ranging from $12{\cdot}5 \times 10^{-4}$ to $0{\cdot}60 \times 10^{-4}$ cm sec^{-1} V cm^{-1}. Both the divided electrode conde method and the whole electrode condenser method were used in investigation.

16274 COEFFICIENT OF DYNAMIC FRICTION FOR SLOW IONS. S.Rand.
Phys. of Fluids (USA), Vol. 4, No. 10, 1251-8 (Oct., 1961).

The coefficient of dynamic friction for a subsonic ion is det mined, in a phenomenological manner, by requiring that the dra force acting on a test particle in a plasma be identical with the drag force on a field particle. The drag coefficient is determin both a fully ionized gas and in a specialized partially ionized ga The effects of collisions between ions and neutral particles on t drag force is considered. It is found that, with some rather con ditions, the stopping power on a charged particle traversing a plasma may be reduced when the density of neutral particles is increased.

16275 DIFFUSION FROM A SLIGHTLY IONIZED REGION IN A UNIFORM FLOW. A.C.Pipkin.
Phys. of Fluids (USA), Vol. 4, No. 10, 1298-1302 (Oct., 1961).

A simplified version is treated of the problem of charge diffusion from the ionized gas behind an infinite plane shock wa in steady motion. The main features of the results are independ of the mechanism of ionization. A charged double layer appear at the upstream edge of the region in which ionization takes pla The electric field between the positive and negative layers is strong enough to prevent any large number of electrons from diffusing far upstream.

16276 ELECTRICAL CONDUCTIVITY OF AIR IONIZED B SHOCK WAVES. P.Valentin.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 215-17 (July 10, 1961 In French.

The conductivity of air ionized in a shock tube is measured using electrodes projecting into the hot gas as described in Abs 6910 of 1961. The constancy of the measured voltage behind the shock front suggests that thermal and chemical equilibrium is reached. Two distinct types of result are obtained for the cond ivity, depending on the shock speed. Slow shocks show an appro mately regular rise in conductivity whilst fast shocks show a pe before equilibrium. The peak is attributed to an overproductio free electrons as suggested by Keck et al. (Abstr. 9405 of 1959) The experimental results are compared with the theoretical Chapman–Cowling conductivity of a weakly ionized gas using experimental molecular cross-sections and theoretical atomic cross-sections. A correction for ionic species is also included The observed behaviour of the conductivity is in reasonable agr ment with theory.
M.McChe

16277 FORMATION OF NEGATIVE IONS IN A GAS BY CHARGE TRANSFER FROM A FAST ATOMIC HYDROGEN BEAM. T.M.Donahue and F.Hushfar.
Phys. Rev. (USA), Vol. 124, No. 1, 138-44 (Oct. 1, 1961).

Structure has been reported (Abstr. 11502 of 1960) in the electron loss cooss-section for hydrogen atoms in H_2. Study of various gases shows that there is no structure for collisions wi argon, but nine peaks of magnitude 10^{-16} cm^2 between 8 and 40 k in CO. Analysis of these peaks support the idea advanced for hydrogen gas that the peaks are caused by formation of negative ions in the target gas by a process in which the electron is capt as though it were a free electron. Mass spectroscopic study re that negative ions are formed when hydrogen atoms pass throug CO, O_2, and H_2O. The formation rate varies in CO as predicted from the σ_{0i} structure (σ_{if} is the cross-section for charge trans where i is the initial charge state of a brem particle and f its final state) and the cross-section is $\sim 10^{-16}$ cm^2. The ions form in CO are CO^- and O^-. The copious production of CO^- contradi the simple model of the capture collision previously proposed.

A METHOD FOR THE MEASUREMENT OF THE MOBILITY ELECTRIC CHARGES IN LIQUIDS. See Abstr. 15904

ELECTRIC DISCHARGES

62?8 SHOCK-EXCITED DARK DISCHARGE. A.S.V.McKenzie, J.F.I.Cole and L.Jacob.
ıre (GB), Vol. 190, 37 (April 1, 1961).
Describes conditions under which current densities of about cm^2 unaccompanied by luminous effects are obtained in harges through hydrogen at pressures of ~ 0.1 mm Hg between e brass electrodes $2\frac{1}{2}$ in. diameter separated by $5\frac{1}{4}$ in.
C.G.Morgan

16279 PRESSURE DIFFERENCES IN A DIRECT-CURRENT CAPILLARY DISCHARGE. D.S.Smith.
ıre (GB), Vol. 191, 265-6 (July 15, 1961).
The pressure differences due to ion and electron motion veen the anode and cathode of a krypton-filled d.c. discharge p were observed as a function of the discharge current with two ani gauges. The pressure difference was found to depend ngly upon the discharge current and amounted to 11 μ of Hg (anode ssure 32 μ of Hg and greater than cathode pressure) when the rent density was 3.0 mA mm^{-2}. This leads to a shift in the 6 μ Kr^{86} spectral line of 2.5 parts in 10^9 along the length of the llary.
G.Carter

16280 SELF-ACCELERATION OF A FLUX OF CHARGED PARTICLES BY INDUCTION. G.A.Askaryan.
mnaya Energiya (USSR), Vol. 6, 658 (1959). In Russian. English slation in: Plasma Phys. —Accelerators — Thermonuclear Res.), Vol. 3, No. 1, 42-4 (Jan., 1961).
Considers some processes which permit the use of the store of rgy in the magnetic self-field of electrons in gas discharges for acceleration of charged particles.
M.Hasan

6281 DENSITY OF CHARGED PARTICLES IN THE CHANNEL OF A SPARK DISCHARGE. A.A.Mak.
eksper. teor. Fiz. (USSR), Vol. 37, No. 5(11), 1488-90 (Nov., 9). In Russian.
The density of charged particles in helium discharges was ained by measurements of the shape, half-width and red-shift of 4686 A line at times between 0.08 and 0.45 μsec after the initia- of the discharge. The experimental conditions were p = 1.5 2 atm, C = 0.05 μF V = 2 to 12 kV and L = 0.18 to 3.6 μH. glish translation in: Soviet Physics—JETP (USA), Vol. 37(10), 5. 1055-7 (May, 1960)].
J.Dutton

16282 A MICROWAVE GASEOUS DISCHARGE STRUCK IN FREE SPACE AT THE FOCUS OF A CLOSED ELLIP- D OF ROTATION. J.Geerk and H.Kleinwächter.
Naturforsch. (Germany), Vol. 16a, No. 3, 320-1 (March, 1961).
German.
Pulsed radiation at 3 cm wavelength is led to one of the foci of llow metal evacuable ellipsoid, by means of an adjustable wave- de. A discharge in free space is obtained spontaneously at the ond focus at gas pressures up to 85 torr. It has roughly spheric- hape, with several other maxima in the surrounding volume.
J.Sheridan

16283 A NOTE ON THE EXPLANATION OF THE TEMPERA- TURE VARIATION IN THE POSITIVE COLUMN.
racík.
ch.J. Phys., Vol. 10, No. 7, 549-50 (1960). In German.
Discusses the kinetic temperature distribution of electrons, s and neutral particles in the positive column.
C.G.Morgan

6284 ELECTRON AND GAS TEMPERATURE IN THE POSITIVE COLUMN OF THE HIGH CURRENT GLOW CHARGE AT ATMOSPHERIC PRESSURE. H.Prinzler.
. Phys. (Germany), Vol. 8, No. 1-2, 42-59 (1961). In German.
Measurements were made of the gradient and current density he positive column of glow discharges in air, N_2, Co_2 and A for rents in the range 50-400 mA. The electron temperature was rmined from measurements of the noise of the discharge at a elength of 20 cm, and was found to lie in the range from about 00° to 22 000°K. Spectroscopic measurements on N_2 showed the gas temperature to increase from about 4000° to 7000°K with in- creasing current. A marked departure from thermal equilibrium was found.
J.Dutton

16285 THE CONNECTION BETWEEN LOW-GRADIENT FORM OF THE POSITIVE COLUMN IN OXYGEN AND MOVING STRIATIONS. L.Pekárek and M.Šícha.
Czech. J. Phys., Vol. 10, No. 10, 749-53 (1960).
The method of sliding photomultipliers was used to study the connection between two forms of the positive column in oxygen, the so-called low-gradient T-form and the high-gradient H-form, and the presence of moving striations in the positive column. It was shown that in the T-form of a positive column striations are always present which move from the cathode to anode with a velocity of several thousand m sec^{-1}. The high-gradient form of the H-pos- itive column, on the other hand, is not striated. The non-single- valuedness of the value of the longitudinal electric field in a dis- charge in oxygen is thus explained by the presence or absence of phenomena of a time variable character.

16286 EMISSION SPECTRA FROM THE POSITIVE COLUMN IN THE GLOW DISCHARGE THROUGH VAPORS OF MONOHALOGEN BENZENES. I. M.Nishi.
J. Sci. Hiroshima Univ. A (Japan), Vol. 24, No. 3, 579-88 (Dec., 1960).
Emission spectra from the positive column in the glow dis- charge through vapours of monohalogen benzenes were investigated in the pressure region 0.1-2 mm Hg. Atomic line spectra from hydrogen and bands from C_2, CH, and H_2 were observed from all reactant vapours commonly. In addition to these spectra, bands from halogens (Cl_2^+, Br_2, I_2) and hydrogen halides (HCl^+, HBr^+, HF^+) were observed from the vapour of each sample respectively. Further, emission continua from Br_2 and I_2 were also observed. From vapour of fluorobenzene continuous spectra like those in the case of benzene vapour and band spectra due to π-electron transitions in the benzene ring were observed. As one of the causes of the marked differences in the discharge behaviour, the differences of dissociation energies between them were noted.

16287 THE COMPLEX CONDUCTIVITY OF THE PLASMA OF A D.C. GLOW DISCHARGE IN Ne.
R.Bakule, M.Šícha, V.Veselý and J.Kracík.
Czech. J. Phys., Vol. 10, No. 10, 754-8 (1960).
An expression derived by Fans for the complex conductivity of plasma assumed that the distribution function of the electrons is Maxwellian and the collision frequency is directly proportional to their velocity. Since the assumptions are approximately satisfied in the positive column of a d.c. glow discharge in Ne, the applicabil- ity of Fang's relation is investigated for this case.

16288 THE ION BALANCE OF THE OXYGEN D.C. GLOW DISCHARGE. J.B.Thompson.
Proc. Roy. Soc. A (GB), Vol. 262, 519-28 (Aug. 8, 1961).
Previously reported measurements (Abstr. 16317 of 1961) of electron energy distribution and ion concentrations in the positive column of an oxygen discharge are used as a basis for discussing the ion equilibrium. The degree of dissociation is shown to be of order 10% and reasons are advanced for the view that negative ions O^- are destroyed in the gas phase by collision with oxygen atoms. A double-sheath criterion is established for an electronegative plasma applicable to the boundary sheaths of striations in the positive column. The ion densities required to satisfy this criterion are not in general the same as those set up by the combined action of generation by electron impact and wall loss with the result that the positive column is unstable.

16289 SPATIAL PERIOD OF MOVING STRIATIONS AS FUNCTION OF ELECTRIC FIELD STRENGTH IN GLOW DISCHARGE. M.Novák.
Czech. J. Phys., Vol. 10, No. 12. 954-9 (1960).
During a systematic investigation of the parameters of a moving stratification in a glow discharge in helium and neon it was found that the spatial period of the striations λ is a simple, unique function of the d.c. (constant) component of the longitudinal electric field strength E. It was found that this dependence is hyperbolic and that the simple relation $E\lambda = \phi_\lambda$ (a constant) thus holds. In the relation ϕ_λ has the significance of a potential fall between the corresponding points of two neighbouring striations and in the measured range of pressures, currents and diameters of

discharge tubes it depends only on the sort of gas and type of striations.

16290 STABILITY OF A GLOW DISCHARGE IN SMALL CURRENTS. V.Krejčí.
Czech. J. Phys., Vol. 11, No. 5, 272-82 (1961). In Russian.

Two approximations of the dynamic characteristic of a glow discharge for small currents are derived. In the first approximation only the influence of the rate of rise and decay of charge carriers in the delay process is accounted for. In the second approximation, the influence of the rate of stabilization of the radial electric field in the discharge is added. On the basis of the derived equations the conditions for the simplest stability of the discharge are calculated. A comparison with experiment gives satisfactory results.

16291 THE CATHODE FALL REGION OF A NON-STATIONARY GLOW DISCHARGE. K.G.Müller.
Z. Phys. (Germany), Vol. 164, No. 1, 40-54 (1961). In German.

The basic equations of the cathode fall region are linearized for small perturbations from the stationary state, based on a one-dimensional model. The linearized system of equations is solved by series expansion in space and time. A resultant linear differential equation for the discharge current and the cathode fall is formulated and the differential characteristic obtained. The selection of the first main terms transforms this differential characteristic into the differential equation of an electric circuit, consisting of an ohmic resistance R, a self inductance L and a capacitance C. The terms R, L, C are given as functions of discharge parameters, which may be determined experimentally or theoretically for the stationary glow discharge. Two different cases are considered. The influence of the ionic transport time through the cathode fall region is first investigated. The second case takes into account the diffusion of metastable atoms from the glow to the cathode. The results may be applied to stability considerations, to investigating the production of oscillations within the cathode fall region and to the describing the glow discharge produced by an external direct voltage and a small superimposed alternating voltage.

CATHODE SPUTTERING IN INERT-GAS GLOW DISCHARGES. See Abstr. 16442

16292 PLASMA DYNAMICS IN AN ARC FORMED BY LOW-VOLTAGE SPARKOVER OF A LIQUID DIELECTRIC.
P.K.Eckman and E.M.Williams.
Appl. sci. Res. B (Netherlands), Vol. 8, No. 4, 299-320 (1960).

An algorithm is derived for the physical conditions in a low-current electrical discharge initiated by low-voltage sparkover between plane electrodes immersed in a liquid dielectric. Calculated results are concerned with column-pressure, temperature, voltage gradient, electron density and column radius for a discharge in a liquid nitrogen dielectric. Of these only column radius can be studied experimentally; experimental results are shown to compare resonably well with predicted results.

16293 ARC INITIATION ON HEATED METALS BY A HYDROGEN DISCHARGE.
J.T.Maskrey, R.A.Dugdale and R.C.McVickers.
Nature (GB), Vol. 190, 997-8 (June 10, 1961).

The formation of unipolar and power arcs at metallic parts exposed to plasma is undesirable in toroidal pinched gas discharges. Investigations on the arcing characteristics of refractory metals exposed to toroidal discharges in pure hydrogen are being carried out. The results so far obtained on the arcing rate as a function of metal temperature support the hypothesis that arcs are initiated through the agency of second phases. A marked transition occurs from an arcing to a non-arcing state during both heating and cooling of the metal. During a course of experiments arcing tends to occur less readily due to a loss from the metal of the arc initiating phases. The depletion of these impurity phases occurs at the surface of the metal, possibly after diffusion from the interior, by vaporization due to electrical breakdown. H.Edels

NOTE ON THE TEMPERATURE DETERMINATION OF THE IRON ARC AND THE DERIVATION OF F VALUES. See Abstr. 16083

ARGON ARC PLASMA GENERATOR. See Abstr. 16346

FIELD EMISSION OF ELECTRONS FROM A SINGLE CRYSTAL OF TUNGSTEN PRECEDING THE DEVELOPMENT OF A VACUUM ARC. See Abstr. 16362

16294 INFLUENCE OF ALLOY STRUCTURE ON THE TRANSFER OF MATTER. W.Merl.
Brit. J. appl. Phys., Vol. 12, No. 9, 447-9 (Sept., 1961).

The influence of conductivity on the transfer of matter at break contact (6 V, 4.3 A, 0.06-20 μH) was investigated for pre tion-hardened gold alloys and a palladium alloy with super-stru For the gold alloys the degree of transfer depends strongly on conductivity in the regions of residual transfer and of normal a but is hardly affected in the region of the short arc.

16295 MEASUREMENT OF METAL TRANSFER IN ELEC RICAL CONTACTS BY THE RADIOACTIVE ISOTOP METHOD. F.Llewellyn Jones, M.R.Hopkins and C.R.Jones.
Brit. J. appl. Phys., Vol. 12, No. 9, 485-9 (Sept., 1961).

The use of radioactive isotopes in the measurement of the t fer of metal from one electrode of an electrical contact to the o is described and details of the experimental procedure are give The relation between matter transfer and circuit inductance at v low values of the inductance was determined for platinum and pa ium contacts operating at potential differences of the order of o volt. It is shown that for these metals there is no range of indu ance down to 10^{-8} H over which the transfer is independent of in ductance. The amount of transfer in relation to the volume of th molten metal bridge between the electrodes is considered, and t significance of the results in the light of theories of the phenom of transfer is discussed.

16296 THE CHARACTERISTICS OF TECHNICAL SPARK-G WITH STRONGLY INHOMOGENEOUS FIELDS. W.Woboditsch.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, 43-6. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Reg

The pre-breakdown phenomena with negative and with positi point, and with a.c. voltages, were examined in detail. K.W.Ples

16297 THE ELECTRICAL BREAKDOWN IN VACUUM. W.J.Wijker.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 1, 1-20 (1961).

Experiments were performed in order to get information about the phenomena preceding the electrical breakdown in sma vacuum gaps. Most experiments were made with impulse voltages of different rise times; some complementary results obtained with alternating voltage are also presented. The effect of surface layers on the pre-breakdown current is discussed. I has been found that the rise time of the voltage affects both the breakdown voltage and the pre-breakdown current. The experi seem to indicate that breakdown in these circumstances is the r of a discharge in metal vapour, originating from the anode. The vapour is thought to be generated by the heating of the anode by a bombardment of field-emission electrons. The transition of t pre-breakdown current to a sudden discharge may occur when t vapour density passes a critical value.

16298 ON A MECHANISM OF BREAKDOWN IN HIGH VACUUM. A.Fryszman, T.Strzyż and M.Wasiński.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 7, 379-83 (1960).

The authors advance a hypothesis that the high voltage vacu breakdown of insulators is the result of stray electrons striking the insulator and releasing secondary electrons from the surfac with a yield greater than unity. The insulator acquires a positi charge which advances towards the cathode. The field strength the cathode thus increases and arcing ensues. Experiments wh tend to confirm this theory are described. G.C

16299 NOTE ON THE MECHANISM OF THE MULTIPACTO EFFECT. F.Paschke.
J. appl. Phys. (USA), Vol. 32, No. 4, 747-9 (April, 1961).

The breakdown in low-pressure gases resulting from r.f.-induced resonance of secondary electrons (known as the multipa effect) has detrimental effects on microwave tube efficiency. A modification to the theory of Kerbs and Meerbach is given which brings the theory into close agreement with the results of Hatch and Williams. The analysis is unidimensional, space charges a ignored, the applied field is assumed sinusoidal and at onset of breakdown one particular velocity class only is assumed to be in resonance and this responsible for breakdown. A condition is

. which, it is suggested, if observed may lead to multipactor- operation of microwave tubes. H.Edels

16300 BEHAVIOR OF EXPLODING GOLD WIRES. T.J.Tucker.
pl. Phys. (USA), Vol. 32, No. 10, 1894-1900 (Oct., 1961).
A square-wave generator current source was used to study the viour of gold wires exploded by current densities in the range $\times 10^8$ to 3.26×10^9 A/cm^2. Measurements of wire resistance, us cumulative energy and action at various current densities, compared with a simple theoretical exploding wire model and esults of Kerr cell photographic studies. Experimentally, the energy input to the time of maximum wire resistance increases current density and may exceed by threefold the normal vapor- on energy. Also, the instantaneous wire resistance at any point naller with larger current density. The resistance depression rst apparent in the region following vaporization. At higher ent densities, the effect is observed to occur at progressively ier phases up to and including the point at which melting occurs.

PLASMA

(See also Magnetohydrodynamics)

6301 VALIDITY OF THE NONLINEAR POISSON–BOLTZMANN EQUATION. N.L.Balazs.
s. of Fluids. (USA), Vol. 4, No. 10, 1259-61 (Oct., 1961).
The validity of the nonlinear linearized equation is analysed by paring analytically and numerically the correct equation of a -dimensional plasma with the approximate ones following from Poisson–Boltzmann equation.

GENERAL SPHERICAL HARMONICS FORMULATION OF .SMA BOLTZMANN EQUATION. See Abstr. 15740

STUDY OF ELECTROMAGNETIC WAVES IN PLASMAS GINNING WITH BOLTZMANN'S EQUATION. See Abstr. 15725

CUT-OFF THEORY OF PLASMA. See Abstr. 15735

.6302 STATISTICAL MECHANICS, DYNAMICS AND MAGNETOHYDRODYNAMICS OF PLASMAS.
ancel and T.Kahan.
iers de Phys. (France), Vol. 15, 57-101 (Feb., 1961). In French.
Starting from Maxwell's transport equation, the equations of ion are deduced for a multi-component gas in the presence of ernal forces. The results are applied to a completely ionized to a partially ionized gas. By coupling these with Maxwell's ctromagnetic equations, the general hydromagnetic equations obtained, and solved in the linear approximation for the tially ionized gas. R.S.Pease

16303 THE ELECTROMAGNETIC ACCELERATION OF A CONTINUOUSLY FLOWING PLASMA.
odolsky and G.Borman.
sma Acceleration Symposium, Palo Alto, Dec., 1959 (see Abstr. 94 of 1961) p. 12-29.
A theoretical discussion of the problem of producing a tinuous stream of high velocity (10^6 to 10^7 cm sec^{-1}) partially zed gas in a steady-state crossed field apparatus by the of a constant $\vec{S} \times \vec{B}$ accelerating force. Three crossed-field ations are given of the hydromagnetic fluid equations (i) the -dimensional flow of an ideal gas, (ii) the radial flow of an l gas of low magnetic Reynolds number, (iii) the radial flow gas (lithium) allowing for real gas properties. The equations solved to find the plasma velocities obtainable for various metrical sizes, applied magnetic fields and gas state variables. required velocities are shown to be obtainable at temperatures 000° K. Some consideration is given to plasma anisotropy the cancellation of its adverse effects. M.McChesney

ELECTRICAL CONDUCTION IN A SIMPLIFIED PLASMA DEL. See Abstr. 151

16304 A GENERAL EXPRESSION FOR THE ELECTRICAL CONDUCTIVITY TENSOR OF A PLASMA IN A CONSTANT MAGNETIC FIELD. D.Quemada.
C.R. Acad. Sci. (France), Vol. 252, No. 20, 3027-9 (May 15, 1961). In French.
Various results are derived for the conductivity tensor, and compared with other workers. It is claimed that the disagreements can be satisfactorily explained by discrepancies in the actual assumptions made. H.N.V.Temperley

16305 TEMPERATURE-CORRECTION TERMS IN THE TENSOR CONDUCTIVITY OF A PLASMA IMMERSED IN A CONSTANT MAGNETIC FIELD. D.Quemada.
C.R. Acad. Sci. (France), Vol. 252, No. 23, 3556-8 (June 5, 1961). In French.
The author comments on the difference between his treatment of the temperature variation of plasma conductivity and those of other workers, and suggests that the important issue is whether the pressure is a scalar or tensor. The conductivity tensor is calculated using the macroscopic hydromagnetic fluid equations together with the general pressure tensor. An auxiliary equation is that of adiabaticity (no heat flow). The equations are linearized and formally solved in an approximate manner. Specific analytical solutions are given for wave perturbations along and normal to the magnetic field and these are found to agree with the results of most other workers who used kinetic methods (Boltzmann's equation) where no adiabaticity condition was explicit. M.McChesney

THEORY OF PLASMA IN A STRONG MAGNETIC FIELD AND THE ENERGY PRINCIPLES FOR EQUILIBRIUM AND STABILITY. See Abstr. 15721

16306 COMPLEX CONDUCTIVITY OF SOME PLASMAS AND SEMICONDUCTORS. P.H.Fang.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 1, 51-64 (1961).
The complex electrical conductivities of plasmas and semiconductors were calculated for several cases where the collision frequency can be expressed as a power function of the energy. From the result, some characteristic parameters of the plasma originally investigated by Spitzer are estimated. The problem of determining the relaxation time from a non-symmetrical dispersion is discussed.

16307 HALL EFFECT IN A LORENTZ GAS. G.W.Sutton.
Phys. of Fluids (USA), Vol. 4, No. 10, 1273-6 (Oct., 1961).
For a Lorentz gas, expressions are derived for the direct and transverse electron electrical conductivities for an arbitrary inverse-power interaction force with the heavy particles. The results are compared to the simple kinetic model for the electron motion. It is found that the simplified equation is not general for small magnetic fields but is correct for large magnetic fields. For inverse powers greater than 3, the error is less than 15%.

16308 CONDUCTIVITY TENSOR OF A HOMOGENEOUS AND SLIGHTLY IONIZED HOT PLASMA. A.Mangeney.
J. Phys. Radium (France), Vol. 21, No. 12, 870-2 (Dec., 1960). — In French.
The results of Bayet, Delcroix and Denisse (Abstr. 2776 of 1955) are extended to the case of a Lorentz gas, the electronic temperature of which is high enough to justify a relativistic treatment. It is shown that the electric conductivity in the direction of the magnetic field is the same as in the paper of Bayet, Delcroix, Denisse. New expressions for the transverse conductivities are given. If the frequency of the electric field is less than the gyromagnetic frequency of the electrons, the method used is valid only for a class of electronic distribution functions.

16309 CONDUCTIVITY OF SEEDED ATMOSPHERIC PRESSURE PLASMAS. L.S.Frost.
J. appl. Phys. (USA), Vol. 32, No. 10, 2029-36 (Oct., 1961).
The electrical conductivity is calculated for some typical seeded gases of magnetohydrodynamic interest. The electron density is obtained using Saha's equation. A method is developed for calculating electron mobility in gas mixtures, taking account of the variation of the scattering cross-section with energy. Scattering by ions is also considered. Results are presented for several gases seeded with small amounts of Cs or K in the temperature range 2000° to 4000° K.

LANDAU DAMPING. See Abstr. 15723

PLASMA TRANSPORT THEORY. See Abstr. 15724

16310 TRANSPORT EQUATIONS FOR PLASMAS IN STRONG EXTERNAL FIELDS. E.Meeron.
Phys. Rev. (USA), Vol. 124, No. 2, 308-10 (Oct. 15, 1961).

In an intense field plasma particles are much more strongly coupled to the field than to each other, the motion of each particle depending on the strength and direction of the field rather than on its individual interactions with other particles. Pair and higher correlations become unimportant, and singlet superposition for the n-particle distribution function provides an excellent approximation. The singlet distribution function is then given by a Vlasov-type transport equation. This conjecture is proven correct on expanding the reduced Liouville equation in powers of a dimensionless field parameter, $\lambda = e/E\alpha^2$ (with α interpreted as an average approach distance), which expresses the ratio of the intensity of inter-particle interactions to that of particle-field interactions; singlet superposition is then exact through terms linear in λ. A general closed hierarchy valid through any given power of λ is derived: solution exact through λ^m retains correlations through order m. Thus it is seen that, as the field becomes weaker, successively higher order correlations become important. Examples of the range of validity of the new treatment are given, and the lack of justification for the use of Boltzmann or Fokker–Planck type equations for microwave plasma diagnostics is briefly discussed, considering the low intensity of microwave beams, and thus the probable importance of pair and higher correlations.

16311 SOME INTERACTIONS BETWEEN CENTIMETRE WAVES AND ELECTRONS IN AN IONIZED GAS.
G.Fornaca, M.Ciampi and M.Reinharz.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 165-70 (1960). In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). A directional coupling produced by a plasma is observed between two waveguides both situated in the same magnetic field and connected by a Pyrex discharge tube. The transmitted power has a maximum near the electron cyclotron frequency. C.J.Ultee

16312 MICROFIELDS IN PLASMA.
K.Hunger and R.W.Larenz.
Z. Phys. (Germany), Vol. 163, No. 3, 245-61 (1961). In German.

By taking full account of the Coulomb interaction and energy conservation, the probability distribution of the electric and magnetic microfields in an ionized gas is calculated. It results in a Gaussian distribution instead of the hitherto used Holtsmark function and its variants, which exhibit certain deficiencies. The mean square electric field is found to be proportional to the temperature, in analogy to the Nyquist formula. The probability of finding an atomic charge in the vicinity of another is established. With this, the time correlation function of the microfield and an average of the correlation time is deduced. Applications to the theory of transport phenomena and spectral line broadening are briefly discussed.

16313 UNIVERSAL REPRESENTATION OF ELECTRO-MAGNETIC PARAMETERS IN PRESENCE OF D.C. MAGNETIC FIELDS.
M.P.Bachynski, T.W.Johnston and I.P.Shkarofsky.
Proc. Inst. Radio Engrs (USA), Vol. 49, No. 1, 354-5 (Jan., 1961).

In an earlier communication [Abstr. 3704 B of 1960; ibid., Vol. 48, No. 3, 347-56 (March, 1960)] the authors gave a graphical representation of the dependence of dimensionless propagation coefficients and a dielectric coefficient of a uniform plasma, in the absence of magnetic field, on dimensionless parameters of the electron density and electron collision frequency (assumed to be constant). In this note the authors point out the applicability of these graphs, in the presence of a magnetic field, when the dimensionless parameters of the electron density and collision frequency are re-defined; these parameters depend on the relative orientation of the magnetic field, the electric vector and the direction of propagation of the electromagnetic wave. M.S.Sodha

16314 A THEORY OF INCOHERENT SCATTERING OF RADIO WAVES BY A PLASMA. II. SCATTERING IN A MAGNETIC FIELD. D.T.Farley, D.W.Barron and J.P.Dougherty.
Proc. Roy. Soc. A (GB), Vol. 263, No. 1313, 238-58 (1961).

For Pt I see Abstr. 19931 of 1960. A general expression for the frequency spectrum of radio waves scattered by the random thermal fluctuations of electron density in a plasma in a magnet field is derived. The derivation is based on the generalized Nyquist noise theorem used in Pt I. The exact result is then simplified by means of an approximation which amounts to assum the velocity of light to be infinite. It is shown that this approxin tion is quite adequate for ionospheric applications of the theory. Next it is proved, without appealing to any approximation, that t magnetic field can never alter the total scattered signal power; can only redistribute this power over the spectrum. Finally, the detailed shape of the frequency spectrum of the scattered signal examined. Analytic expressions are given for certain limiting cases, but for the cases of most interest, numerical methods mu be used. The results of some numerical calculations are shown From these results, it can be seen that the magnetic field has a significant effect on the shape of the spectrum only if the inciden radio beam is very nearly orthogonal to the magnetic lines of fo For example, for an operating frequency of 40 Mc/s, no significa magnetic effect is observed even when the beam is within 5° of orthogonality. As this angle is decreased further, however, the spectrum rapidly begins to develop spikes at Doppler shifts whic are approximate multiples of the ion gyro-frequency. These spi are quite pronounced when the beam is 2° from orthogonality. A higher operating frequencies, the beam must be proportionally closer to orthogonality to achieve the same effect.

16315 ELECTRON ENERGY DISTRIBUTIONS IN PLASMAS. II. HYDROGEN. R.L.F.Boyd and N.D.Twiddy.
Proc. Roy. Soc. A(GB), Vol. 259, 145-59 (Dec. 6, 1960).

The method reported in Pt I (Abstr. 7117 of 1960) is applied the study of the mechanism of striation structure in hydrogen discharges, in the pressure range 0.01 to 0.1 mm Hg and the cur range 0.016 to 0.800 A. The basic relations governing the curre flow, ionization rate and energy flux are established and verified These relations and this mechanism are not specific to hydrogen The measurements reveal insufficient electrons with energy cap of producing H^+ and H_2^+ directly, though it is possible that electr having passed through two striation heads may make an importan contribution. In view of earlier reports of the predominance of H_3^+ in such discharges it is tentatively suggested that the proces $H' + H_2 \rightarrow H_3^+ + e$ may be important.

16316 ELECTRON ENERGY DISTRIBUTIONS IN PLASMAS. III. THE CATHODE REGIONS IN HELIUM, NEON AN ARGON. N.D.Twiddy.
Proc. Roy. Soc. A (GB), Vol. 262, 379-94 (July 18, 1961).

The Druyvesteyn method of measuring electron energy distri butions in low-pressure plasmas was applied to the cathode regio of hot cathode discharges in helium, neon and argon at a pressur of 0.05 mm Hg. In all gases the column was striated. In helium and neon, measurements in the striation nearest the cathode sho two well separated groups of electrons, the more energetic or primary electrons arising from the Langmuir double space-char sheath at the filament; the lower-energy group or secondary electrons being produced by the primary electrons in inelastic collisions. The concentrations of both groups fall off with increa distance from the filament, but their separation and energy spre is constant throughout the striation, indicating the absence of any energy exchanging process capable of appreciably modifying the energy distribution. It would appear therefore that the energy-exchanging processes observed by Langmuir (1925), by Merrill a Webb (1939), and by Gabor, Ash and Dracott (1955) were inoperat in the discharges employed in the present experiments. In the absence of an energy-exchanging process a uniform column cann arise at the pressures employed, since in order to give rise to a truly uniform column the axial field must extend over many mean f paths, a condition which is not fulfilled in these discharges, since the entire discharge tube is less than 100 mean free paths long a thus on the average an electron makes fewer than 1000 collisions between cathode and anode. The application of an axial field sim augments the energy of the electrons without modifying the broad features of the energy distribution. If therefore the energy distri bution consists of two separate groups of electrons a uniform fie can maintain the discharge while primary electrons remain, but when these are exhausted, because of the distinct separation bet-ween the primary and secondary groups, new primary electrons can only by created by a step of potential. Under these condition the striated column will exist and a transition to a stable uniform column is only to be expected when a mechanism exists for modi fying the energy distribution in a few mean free paths. Measure-

ts at higher currents in helium and neon show a definite ency for the trough between the two groups to be eliminated; is presumably due to secondary processes. The presence of a metastable concentration enables both primary and secondary ips to be modified by secondary collisions,thus eliminating the rp demarcation between the two groups which was evident at er currents. It seems possible also that the disposition of the t critical potential in a gas may influence its ability to develop iform column, since if the first excitation potential is appreci- less than half the ionization potential the primary and second- groups will overlap. This might be effective in the metal ours. The probable influence of impurities on the appearance ne discharge and the energy distribution are considered on the is of the data available from measurements in hydrogen, helium neon. Measurements in the negative regions in argon, while wing features characteristic of the striated column, were quite erent in character from the other rare gases in that a fairly ong but decreasing field existed in the tube. Measurements here w very clearly how a uniform field augments the energy of the ctrons without modifying the broad features of the distribution.

16317 ELECTRON ENERGY DISTRIBUTIONS IN PLASMAS. IV. OXYGEN AND NITROGEN. J.B.Thompson.
ic. Roy. Soc. A (GB), Vol. 262, 503-18 (Aug. 8, 1961).

The Druyvesteyn method of measuring electron energy distri- ions in low pressure plasmas was applied to cold-cathode direct rent glow discharges in oxygen and nitrogen at pressures in the ge 0.010 to 0.050 mm Hg. Two discharge modes occurred in n gases. Mass spectrometer measurements showed that in ·ogen only N_2^+ was present but in oxygen the ions O^-, O_2^-, O^+, O_2^+, ·e all present. O^- and O_2^+ concentrations were about equal in gnitude and formed over 90% of the ions present. Electron energy tributions in the positive column showed three groups in oxygen nitrogen. The data available from the oxygen discharge are sistent with the lowest energy peak being a manifestation of a ge negative ion concentration ($n_-/n_e = 20$).

16318 ELECTRON–HEAVY PARTICLE COLLISION MODEL IN A PLASMA.
Koga, J.G.Everton and P.C.Wilber.
ys. of Fluids (USA), Vol. 4, No. 8, 1057-8 (Aug., 1961).

Proposes a form of the Boltzmann equation which takes account recombination and ionization collisions, as well as scattering lisions, between electrons and heavy particles. R.S.Pease

16319 ON THE STRUCTURE OF GENERALIZED FOKKER–PLANCK EQUATION OF A HIGH TEMPERATURE PLASMA. Y.H.Ichikawa and Y.Sasakura.
ogr. theor. Phys. (Japan), Vol. 25, No. 6, 989-1005 (June, 1961).

The structures of the generalized Fokker–Planck equation e examined in detail by considering the motion of an electron am in a high temperature electron plasma. The dynamical shield- factor provides the basis of a unified theory of plasma oscilla- ns and the static shielding of the particle interaction in the plasma. e friction and diffusion coefficient are calculated by taking into nsideration the non-local space–time correlation effect. It is own that the non-local correlation effect substantially modifies e contributions of the plasmon emission process. Rough estima- n of the friction coefficient shows that the non-local correlation fect may increase the amount of the frictional drag at higher locity. This effect may be essential to resolve the Langmuir radox.

16320 THE FRICTION AND DIFFUSION COEFFICIENTS OF THE FOKKER–PLANCK EQUATION IN A PLASMA.
Hubbard.
oc. Roy. Soc. A (GB), Vol. 260, 114-26 (Feb. 7, 1961).

In a recent paper by Thompson and Hubbard (Abstr. 5446 of 61) it was shown how the diffusion coefficients of the Fokker– anck equation could be calculated in the case of a plasma in rmal equilibrium by a method which included automatically rrelation effects and avoided the use of a cut-off procedure. In s paper the method is extended to plasmas not in thermal uilibrium and a calculation of the friction coefficient is given.

16321 THE FRICTION AND DIFFUSION COEFFICIENTS OF THE FOKKER–PLANCK EQUATION IN A PLASMA. II.
Hubbard.
oc. Roy. Soc. A (GB), Vol. 260, 371-87 (May 16, 1961).

The theory is extended to include a proper treatment of close ary encounters. It is also shown that the higher-order terms of the Fokker–Planck equation may be summed to produce a Boltzmann-like contribution to the collision term. Finally, it is shown that in the approximation in which only "dominant" terms are retained, the theory reproduces a number of well-known formulae, including the ordinary Boltzmann collision term, but now with a suitable cut-off built in.

16322 DIFFUSION AND RECOMBINATION OF A HIGHLY IONIZED COLD PLASMA IN A MAGNETIC FIELD.
N.D'Angelo and N.Rynn.
Phys. of Fluids (USA), Vol. 4, No. 10, 1303-6 (Oct., 1961).

Measurements of the diffusion coefficients of cold, highly ionized caesium and potassium plasmas across a magnetic field are described. The field was varied between 3000 and 9000 gauss, the ion density between 10^{10} cm^{-3} and 10^{12} cm^{-3}. No current was passed through the plasma. The results support the view that diffusion proceeds according to the predictions of the classical theory ($D_\perp \sim 1/B^2$). No agreement is possible with Bohm's diffusion theory. Also, some support is given to the theory of recombination through electron-electron-ion collisions and radiative cascading between excited states.

16323 HIGH-FREQUENCY TAIL OF CYCLOTRON RADIATION FROM A HOT PLASMA. J.D.Jukes.
Phys. of Fluids (USA), Vol. 4, No. 9, 1184-5 (Sept., 1961).

Estimates the effect of surrounding a plasma by a reflector. Concludes that both the "blackbody" and "high-energy" radiation losses can be reduced considerably. H.N.V.Temperley

16324 REPLY TO COMMENT OF J.D.JUKES.
J.L.Hirshfield and S.C.Brown.
Phys. of Fluids (USA), Vol. 4, No. 9, 1185 (Sept., 1961).

In reply to the preceding abstract the authors point out that Jukes has omitted a term in calculating losses from the plasma, and also concede that the estimates in a former paper (Abstr. 4608 of 1961) were too crude. Some revised calculations are presented and discussed. H.N.V.Temperley

16325 EXCITATION OF ELECTROMAGNETIC WAVES IN A MAGNETO-ACTIVE PLASMA BY A BEAM OF CHARGED PARTICLES. K.N.Stepanov and A.B.Kitsenko.
Zh. tekh. fiz. (USSR), Vol. 31, No. 2, 167-75 (Feb., 1961). In Russian.

Considers Cherenkov and cyclotron excitation of "slow" electromagnetic waves in a plasma by a beam of charged particles which moves through the plasma; the motion of the beam is parallel to the external magnetic field. [English translation: Soviet Physics–Technical Physics (USA), Vol. 6, No. 2, 120-6 (Aug., 1961)].

16326 SOME MEASUREMENTS OF FLUCTUATIONS IN A PLASMA. F.W.Crawford and J.D.Lawson.
Plasma Phys–Accelerators–Thermonuclear Res. (GB), Vol. 3, No. 3, 179-85 (July, 1961).

Measurements of the fluctuations in anode voltage, tube current, and number density were made in a hot-cathode mercury-vapour discharge at a pressure of about 1μ, under both space-charge limited and temperature-limited emission conditions. Substantial low-frequency fluctuations occur from zero to several hundred kc/s with strong components at about 60 and 100 kc/s. Potential distribution curves show noise generation over the first 20 cm of the plasma column. This is poorly correlated from point to point but appears to propagate with a velocity of the same order as the electron thermal velocity. Over the remaining 60 cm of the experimental tube, the signal is well correlated and travels at more than 10^9 cm/sec. Despite the non-uniform noise distribution, the column appears as a uniform impedance (to external signals), and an approximate expression has been derived for its impedance/frequency characteristic. Number density measurements, made by a microwave cavity perturbation technique, indicate fluctuations increasing in amplitude towards the cathode, and persisting even when the discharge is temperature-limited and other fluctuations have been substantially reduced.

16327 CHARACTERISTIC FUNCTIONAL FOR PLASMA TURBULENCE. K.Goto.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 603-12 (April, 1961).

The functional analytical description of magnetohydrodynamic turbulence of an incompressible plasma flow is investigated by the method introduced by Hopf (1952) for ordinary hydrodynamic

turbulence. An exact stationary solution of the functional differential equation for the characteristic functional is given for the special case of inviscid and infinitely conducting plasma. This solution shows the equipartition of the kinetic and magnetic energies. A formal general solution is also obtained by assuming the possibility of the functional Fourier transformation.

16328 ON THE INSTABILITY OF AN INHOMOGENEOUS RAREFIED PLASMA IN A STRONG MAGNETIC FIELD.
L.I.Rudakov and R.Z.Sagdeev.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 3, 581-3 (May 21, 1961).
In Russian.

The problem of the instability of an inhomogeneous plasma (with variable particle density and variable temperature) is investigated in the presence of a strong magnetic field and an electric current. Criteria for instability are obtained in two special cases (a) when the plasma is isothermal but inhomogeneous regarding particle density and (b) when the plasma is homogeneous but non-isothermal. The mechanism of instability arising in the latter case is also physically explained. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 415-17 (Oct., 1961)].
S.P.Talwar

16329 LIMITING VELOCITY FOR A ROTATING PLASMA. S.C.Lin.
Phys. of Fluids (USA), Vol. 4, No. 10, 1277-88 (Oct., 1961).

A quasi-steady state solution is obtained for a homogeneous plasma undergoing simultaneous ionization and rotation in a crossed electric-magnetic field. It is found that the ordinary electron-impact ionization process, when supported by the full rate of energy transfer from the ions to the electrons via Coulomb collisions, will be sufficiently rapid to provide a close coupling between the kinetic energy of the ions and the ionization energy of the neutrals under a wide range of conditions. The results can be used to interpret the limiting velocity observed by Alfvén (Abstr. 5447 of 1961) and Fahleson (Abstr. 2980 of 1961) in some recent rotating plasma experiments. The same results can also be used to predict the occurrence of similar limiting velocity in some rectilinear plasma accelerators.

16330 THE DYNAMICS OF HIGH TEMPERATURE PLASMAS. W.B.Thompson.
Rep. Progr. Phys. (GB), Vol. 24, 363-424 (1961).

A survey is given of present models of the dynamic behaviour of a fully ionized plasma, with particular emphasis on those useful in stability studies. The models discussed include magnetohydrodynamics which, while not fully justified, is widely used, the classical kinetic theory which probably is not applicable to hot laboratory plasmas, and the collisionless kinetic theory, which while incomplete seems suited to the discussion of the stability of plasmas. The properties of small oscillations are discussed, both sound waves and electrical oscillations, and stress is laid on the dielectric behaviour of the plasma. A consistent derivation of the Fokker–Planck equation is sketched, using the dielectric properties of the plasma. Many important dynamical problems are omitted — there is no discussion of the collisionless shock, or of the breakdown of hydrodynamic behaviour through electron runaway in electric fields and there is little discussion of particular configurations.

16331 REFLECTION OF ELECTROMAGNETIC WAVES AT ELECTRON DENSITY RAMPS. L.S.Taylor.
J. appl. Phys. (USA), Vol. 32, No. 9, 1796-7 (Sept., 1961).

The object of this investigation is to determine the depth to which a plane TE wave penetrates an electron density profile consisting of a ramp. The author obtains the reflection coefficient for such a wave incident on a ramp ending in a perfectly conducting wall. The penetration depth is defined qualitatively as that distance of the wall from the commencement of the ramp at which the reflection coefficient is approximately equal to that when the wall is an infinite distance from the start of the ramp. By investigating the variation of the reflection coefficient with wall position the author obtains criteria to determine the penetration depth.
W.E.Williams

16332 PLASMA PRODUCTION BY TRAVELING RESONANT PERTURBATIONS. W.I.Linlor.
Phys. Rev. Letters (USA), Vol. 7, No. 4, 115-7 (Aug. 15, 1961).

Proposes to produce plasma in mirror-type geometry by axial injection of ions, with a unidirectional travelling perturbation of the main magnetic field, with velocity and frequency chosen t produce nonadiabatic trapping of the particles. R.S.F

16333 NEW METHOD OF CONFINEMENT IN PLASMAS. EXAMINATION OF THE PRINCIPLES OF OPERAT
M.Haegi.
Arch. Sci. (Switzerland), Vol. 13, No. 4, 508-18 (Oct.-Dec., 196
In French.

Considers the case of a cylindrical D—T plasma in an axia magnetic field in which the ion orbits all pass through an axial at the centre. This is considered to give a high central density following parameters are calculated: central density, fusion pr ability, collision probability outside the centre, charge exchang stability, bremsstrahlung and cyclotron radiation intensities an diamagnetic limitation. J.W.Stur

16334 THE CONFINEMENT OF PLASMA BY THE HELIO MAGNETIC FIELD. K.Uo.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1380-95 (July, 1961).

A magnetic field named the Heliotron field is produced by t electric current in a series of pair coils wound around the discharge tube with regular intervals. The electric current in each coil of the pair differs both in intensity and direction. The lines of force in this field undulate near the tube axis without cu ting the wall, while those near the tube wall cross the wall. Th the high temperature plasma can be produced by ohmic heating in the central region of this field being prevented from touching the wall. This field is found to satisfy the necessary condition the equilibrium. The interchange instability of the plasma conf in this field is discussed. A general expression is given for the magnetic field, and it is shown that the Heliotron B magnetic fie the cylindrical cusp field, the helical winding field of the Stella and the Picket-Fence field are derived as special cases of this general formula.

16335 EXPERIMENTAL AND THEORETICAL OBSERVATI ON A FAST LINEAR PINCH.
D.E.T.F.Ashby, K.V.Roberts and S.J.Roberts.
Plasma Phys. —Accelerators—Thermonuclear Res. (GB), Vol. No. 2, 162-6 (April, 1961).

Preliminary experimental data obtained from a preionized 140 kA, 12 μsec shock-heated linear z-pinch discharge are com pared with calculations on a computer programme which solves the magnetohydrodynamic equations for the collapse of a fully- ionized cylindrical plasma. C.G.Mc

16336 HYDROMAGNETIC SHOCK WAVES IN LINEAR PINCH COLLAPSE. W.Köppendörfer.
Z. Naturforsch. (Germany), Vol. 16a, No. 5, 484-91 (May, 1961)
In German.

The purpose of the experiments was to achieve hydro- magnetic shockwaves on a linear pinch collapse. To approach t hydromagnetic two-fluid model a strong pre-ionization was use If the conductivity of the plasma is high and the gas fully ionize the mass density must be proportional to the stabilizing field within the current sheet. In this way the structure of shockwav could be obtained from magnetic field measurements.

16337 PROPULSION FROM PINCH COLLAPSE. S.Gartenhaus and L.M.Tannenwald.
Plasma Acceleration Symposium, Palo Alto, Dec., 1959 (see Abstr. 10694 of 1961) p. 73-8.

A theoretical study of the thrust available from the collaps of a pinched discharge between a pair of axi-symmetric electro such that the plasma has a large opening angle i.e. shaped like a truncated cone. The plasma which is assumed to be of very high conductivity and collision free has an imploding boundary governed by a Rosenbluth-type equation. Particles are reflecte from the collapsing sheet of current and gain momentum: this results in the plasma receiving a net component of velocity along the pinch axis. It is envisaged that this transient device operate in a pulsed cycle and thereby provide an average thrust for propulsion. M.McChe

16338 PLASMA PROPULSION BY MEANS OF A TRAVELI SINUSOIDAL MAGNETIC FIELD. R.X.Meyer.
Plasma Acceleration Symposium, Palo Alto, Dec., 1959 (see Abstr. 10694 of 1961) p. 37-46.

A theoretical study of a two-dimensional sinusoidal magnet field transverse to the horizontal plane of symmetry of a rectangular channel which progresses along the channel and

by accelerates the plasma. The one-fluid magneto hydro-nic equations for an ideal gas (scalar pressure and conduc-) are set up and solved on the assumption of a vanishingly l magnetic Reynolds number. A numerical example is given ydrogen at 30 000°K and a density of 3×10^{-2} times normal ity. M.McChesney

ACCELERATION OF METAL-DERIVED PLASMAS.
6339 W.L.Starr and J.T.Naff.
ma Acceleration Symposium, Palo Alto, Dec., 1959 (see r. 10694 of 1961) p. 47-59.
Describes laboratory plasma accelerators and their ɔrmance. Three accelerator geometries are discussed: rectangular (T-type) geometry where the plasma is introduced aporizing wire lying normal to the main discharge electrodes, ı similar geometry but where the plasma is obtained from tering and arc erosion of the discharge electrodes. To ate the discharge a small amount of A is admitted, (iii) a ial geometry where the plasma is derived from a vaporizing . The plasma impulse is measured by a ballistic pendulum. netry (i) gave a plasma front velocity of 8×10^6 cm sec^{-1}, pendent of wire diameter and material. The gun efficiency ɔver depended greatly on wire diameter, being 40% for wires and 4% for thick wires (0.5 to 5.0 mil). Geometry (ii) ɔed that the total mass eroded is proportional to the square of ɔapacitor voltage. Geometry (iii) showed that better control ıe injected mass can be obtained with this configuration; fficiency of about 30% was obtained. M.McChesney

THE USE OF PLASMA FOR PROPULSION OF
6340 INTERPLANETARY ROCKETS. C.L.Longmire.
ma Acceleration Symposium, Palo Alto, Dec., 1959 (see r. 10694 of 1961), 2-11.
Reviews present day plasma propulsion devices and shows ı to give insufficient thrust-to-mass ratio to allow escape ı planetary surfaces. Their use is confined to supplying the ɔrence between orbital and escape velocities during interplanet- manoeuvres. A one dimensional hydromagnetic analysis of ıgnetic coaxial convergent–divergent nozzle is given and the ɔr requirements to propel a rocket of 10^6 gm mass with an ust velocity of 30 km sec^{-1} and an acceleration of 1 cm sec^{-2} given: these amount to the need for a 50 V generator capable ıpplying a d.c. current of 3×10^6 A. The plasma is assumed to be um. M.McChesney

SCALING RELATIONS FOR PLASMA DEVICES.
16341 G.S.Janes.
ɜma Acceleration Symposium, Palo Alto, Dec., 1959 (see tr. 10694 of 1961) p. 30-6.
Gives the theoretical scaling relations for plasma devices ɔh operate using an ideal magnetically confined, fully-ionized ma where Coulomb interactions dominate and where the ɔnetostatic energy density is greatly in excess of the electro-ic energy density. The laws show an unfavourable scaling ɔeen physical size and operating power level, suggesting the ɔessity of making small laboratory devices pulsed rather than ınuous in order to avoid excessive energy densities, pressures heat transfer rates. M.McChesney

HYDROMAGNETIC PLASMA GUN.
16342 J.Marshall.
ɜma Acceleration Symposium, Palo Alto, Dec., 1959 (see tr. 10694 of 1961) p. 60-72.
Describes laboratory experiments made on several coaxial plasma guns where the plasma is created from small amounts as admitted by an impulsively operated mechanical valve. The performance was obtained from an open-ended linear pinch re the pinch compressed plasma could escape through a hole ne of the electrodes. Plasma velocities of 10^7 cm sec^{-1} were ined by the direct $j \times B$ forces on the radial component of the ɔent which flowed from the end of the pinch into the ring electrode. surements were made on the plasma using a ballistic pendulum ɔying a thermocouple. Simple energy and momentum balance ıtions are given and related to the electrical input parameters. ɔtroscopic studies of plasma purity were made and a mass ɔtrographic analysis of the plasma showed considerably higher velocities than expected. M.McChesney

EFFICIENCY CONSIDERATIONS IN ELECTRICAL
16343 PROPULSION. S.W.Kash.
Plasma Acceleration Symposium, Palo Alto, Dec., 1959 (see Abstr. 10694 of 1961) p. 79-93.
A theoretical analysis of the efficiencies of two types of plasma accelerator. The first type is the pulsed beam accelerator (T-type Kolb tube). This is analysed by an equivalent circuit technique with time-dependent resistance and inductance of the plasma. For efficient operation circuit resistance and inductance must be minimized and the rate of change of plasma inductance must be maximized to keep the ratio of ohmic heating to mechanical work done on the plasma as low as possible. Accelerator efficiencies are computed for various fixed circuit parameters and it is shown that 70-80% conversion of electrical energy to plasma kinetic energy is possible by careful design. The second type is a continuously operating cylindrically-symmetric electrostatic ion accelerator. Alkali ions produced at a high-temperature porous anode are accelerated by an electric field and beam neutralization is achieved by using electrons from a thermionic source. The main disadvantage of this type of accelerator is the radiation loss from the ion and electron sources. The ratio of thermal radiation lost to power supplied to the ions (which alone, are responsible for the thrust) is computed as a function of gas geometry and available perveances. M.McChesney

APPARATUS FOR PRODUCING AN ARC PLASMA
16344 SUITABLE FOR INJECTION INTO A MAGNETIC BOTTLE. C.Brachet and P.Vasseur.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 86-8 (July 3, 1961). In French.
Briefly discusses limitations of present techniques for high-energy injection into magnetic bottles. Describes an arc produced in a Philips ionization gauge consisting of two cathodes and two anodes facing each other. Gas is injected into the discharge through a small hole in the cathode and thence through a larger hole in the related anode. The gauge is mounted in an axial magnetic field. The voltage–current behaviour of the gauge shows two regimes of operation. The first in the normal mode of operation for currents of less than 40 mA, namely the discharge in a cylinder of plasma of diameter equal to the anode hole diameter. For higher currents the discharge forms as a bright filament of diameter equal to the gas inlet hole of the cathode. Experiments on this new mode of operation show that the voltage is independent of the current but depends upon the gas pressure and field strength. M.McChesney

THE CHARACTERISTICS OF THE DISCHARGES IN THE
16345 CROSSED ELECTRIC AND MAGNETIC FIELD.
Sh.Hayakawa and T.Suita.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1037-8 (May, 1961).
Describes a device similar to the Berkeley homopolar machine. A delay was found between the application of the electric field and the onset of the discharge. As the applied voltage was raised the delay time decreased due to the increased ionization efficiency of the higher energy electrons. J.W.Sturgess

EFFECT OF AN AXIAL MAGNETIC FIELD ON THE
16346 FLOW IN THE NOZZLE OF A PLASMA GENERATOR.
M.H.Jacquelin.
J. Rech. Cent. Nat. Rech. Sci. (France), No. 5, 61-3 (March, 1961). In French.
The paper gives details of a plasma generator ("plasmatron") using a 600 A argon arc. Without a magnetic field along the nozzle axis the arc dissipation fluctuates and cathode spots are visible. On application of an axial field of between 2-5 kG the cathode spots disappear and the arc dissipation becomes constant. The author remarks on the observed changes of gas pressure, energy output (measured electrically and calorimetrically) and magnetic field strength. No theory is given. M.McChesney

THE IONIC CENTRIFUGE AND FUSION NUCLEAR
16347 POWER. J.Slepian.
Proc. Nat. Acad. Sci. USA, Vol. 47, No. 3, 313-19 (March, 1961).
The "ionic centrifuge" is a low-voltage arc surrounded by a cylinder and end-plates, the voltages applied to the cylinder and end-plates being, in general, different. A uniform magnetic field is applied along the cylinder. The only condition actually studied is that in which the end-plates are made negative but the cylinder is allowed to float, but predictions are made about the motion of ions and electrons in other conditions. It is claimed that, in certain

circumstances, a partial separation of electrons and ions occurs, the end-plates drawing half the ions and no electrons. It is also claimed that the ions attain very high energies during part of their lifetime, but that they cannot reach the electrodes at this stage. It is therefore suggested that a fusion reactor could be based on this principle. H.N.V.Temperley

16348 PARTICLE SURFACES FOR HIGH-ENERGY ELECTRONS IN A STELLARATOR.
E.B.Meservey and L.P.Goldberg.
Phys. of Fluids (USA), Vol. 4, No. 10, 1307-14 (Oct., 1961).

A simple theory of high-energy ("runaway") electron surfaces in a stellarator is presented. X-ray intensity measurements qualitatively confirm the prediction of the simple theory, namely that, in a machine whose figure-eight twist is negative (i.e., each U bend rotated counterclockwise as seen from beyond that U bend) runaway surfaces drift toward the centre of curvature (inside) of the stellarator loop for accelerating field E parallel to confining field B and toward the outside for E antiparallel to B. The time behaviour of X-ray intensity indicates that the actual runaway surfaces do not have the predicted circular cross-section but have, superposed on this, perturbations of m-fold azimuthal symmetry at values of plasma current corresponding to the predicted ranges for various modes of the "kink" instability.

16349 LIFETIMES OF FAST IONS IN THE PLASMA OF D.C.X.
C.F.Barnett, J.L.Dunlap, R.S.Edwards, G.R.Haste, N.Postma, J.A.Ray, R.G.Reinhardt, W.J.Schill, R.M.Warner and E.R.Wells.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 589-91 (June 1, 1961).

A 600 keV, 1.4 mA H_2^+ beam was injected into a 2 : 1 mirror geometry, with a central magnetic field of 10 kG, at a base pressure of 5×10^{-8} mm Hg. Dissociation by residual gas created about 10^3 cm^3 of plasma with a fast proton density of 10^7 cm^{-3}. The loss of fast protons by electron capture collisions was measured as a function of background pressure and gas type. Exponential plots of flux versus time were obtained, giving containment times of several seconds, with electron capture collisions the only apparent mechanism of loss. R.S.Pease

SCEPTRE III NITROGEN EMISSION SPECTRUM.
See Abstr. 13945

Plasma Oscillations

16350 DISPERSION RELATIONS IN A STATIONARY PLASMA.
B.S.Tanenbaum.
Phys. of Fluids (USA), Vol. 4, No. 10, 1262-72 (Oct., 1961).

The two-fluid theory for a fully ionized, macroscopically neutral plasma is used to examine small-amplitude normal mode oscillations in an infinite, homogeneous medium for three cases: no applied magnetic field; a magnetic field in the direction of wave propagation; and a magnetic field perpendicular to the direction of wave propagation. In the field-free case, which has been treated in a similar way by Pai (Abstr. 5483 of 1961), the dispersion relations for the three simplest types of plasma oscillations — longitudinal electron waves, longitudinal ion waves, and transverse waves — are verified and the properties of each of these waves are described. In the second and third cases, the influence of an applied magnetic field on the normal mode solutions is studied and the results of this complete two-fluid theory are compared with the analogous results obtained in the simpler theories of Appleton (magneto-ionic theory) and of Alfven (magnetohydrodynamics).

16351 ION CYCLOTRON RESONANCE IN DENSE PLASMAS.
L.V.Dubovoi, O.M.Shvets and S.S.Ovchinnikov.
Atomnaya Energiya (USSR), Vol. 8, 316 (1959). In Russian.
English translation in: Plasma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 3, 203-8 (July, 1961).

The feasibility of heating plasmas by using the mechanism of ion cyclotron resonance has been investigated. It is shown, that in plasmas with a density of charged particles of 10^7 -10^{11} cm^{-3} the effect of transverse ionic polarization fields can be reduced by the use of heating units which are short relative to the length of the plasma column, on account of the motion of electrons from the discharge along the lines of force of the external magnetic field. In a plasma with a low degree of ionization, a strong reduction is observed in the efficiency of transfer of energy from the high-fr ency field to the ions with increase of their velocities. This is associated with cooling of the ions by neutral atoms.

16352 CONNECTION BETWEEN OSCILLATION AND RATE OF LOSS OF CHARGED PARTICLES IN A CYLINDRICAL PLASMA OF LOW PRESSURE IN A LONGITUDINAL MAGNETIC FIELD. A.A.Zaitsev and M.Ya.Vasil'eva.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 5, 1639-40 (May, 196 In Russian.

A 50 to 350 mA discharge, 90 cm long, was run in helium at 0.05 to 0.2 mm Hg in a 2 cm bore tube. A variable axial magnetic field of up to 2500 Oe could be applied. At a certain critical magnetic field, which depended on the pressure, the electrical noise level in the discharge abruptly increased by a factor of 10 to 15 and simultaneously the anode current decreas by 5 to 8 % while the voltage gradient increased. The oscillatio appeared to propagate toward the anode at a speed comparable with the electron drift velocity, and they enhance the diffusion current to the tube wall. [English translation in: Soviet Physic JETP (USA), Vol. 11, No. 5, 1180-1 (Nov., 1960)] D.M.Gi

16353 THE INTERACTION OF FAST ELECTRON BEAMS WITH LONGITUDINAL PLASMA WAVES.
Yu.A.Romanov and G.F.Filippov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 123-32 (Jan., 1961 In Russian.

Equations are derived that yield the time variation of the plasma wave spectral density and of the fast electron distributio function for arbitrary velocity distributions. The dispersion relation for the stationary problem is solved, and the spatial ex of the exponential stage of the slowing down of the monochromat beam estimated. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 87-93 (July, 1961)].

16354 COMMENTS ON "RADIATION BY PLASMA OSCILLATIONS". D.A.Tidman.
Phys. of Fluids (USA), Vol. 4, No. 9, 1186 (Sept., 1961).

Corrects an error in a former paper (Abstr. 10725 of 1961) emission of radiation when plasma oscillations are scattered by inhomogeneity in the plasma. Also, a formula in the paper is carried to a higher approximation. H.N.V.Tempe

16355 EFFECT OF COLLISIONS ON THE LANDAU DAMPI OF PLASMA OSCILLATIONS.
P.M.Platzman and S.J.Buchsbaum.
Phys. of Fluids (USA), Vol. 4, No. 10, 1288-92 (Oct., 1961).

The effect of collisions on the Landau damping of a one-dimensional longitudinal plasma oscillation in the absence of a magnetic field is analysed. It is found that in a steady state, collisions (no matter how few in number) affect the velocity distribution of the trapped electrons and thus play a major role determining the Landau damping. When the damping is small ($\mathrm{Im}\,k \ll \mathrm{Re}\,k$), it is reduced from its collisionless value by a factor $\nu_c^2/(\nu_c^2 + \Omega^2)$ where ν_c is the electron collision frequenc momentum transfer and $\Omega^2 = eKk/m$ is the frequency of oscillati of a trapped electron in the approximately parabolic potential tr of the wave.

MAGNETO-PLASMA RESONANCE IN SEMICONDUCTORS
See Abstr. 14406

ELECTRON EMISSION
ELECTRON BEAMS

16356 THE INFLUENCE OF LIQUIDS ON THE TRIBO-STI LATION OF ALUMINIUM LEADING TO PHOTOSTIM LATED EXO-ELECTRON EMISSION. T.Lewowski and B.Sujak
Acta phys. Polon. (Poland), Vol. 20, No. 2, 119-27 (1961). In Ge

Samples of Al were abraded with a steel brush or with a fil and the photostimulated exo-electron emission determined using point counter. The effect of various organic liquids, applied to Al surface after abrasion, was investigated. Using the steel bru liquids containing O or H caused a quenching of the emission, bu other liquids had no effect; but in the case of filing all the liquid investigated caused some quenching. The results are discussed terms of chemical effects at the sample surface. C.H.B

WORK FUNCTION OF THE GOLD–BARIUM SYSTEM.
Abstr. 15174

ON THE PROBLEM OF EXO-ELECTRON EMISSION.
6357 R.Seidl.
h. J. Phys., Vol. 10, No. 12, 931-48 (1960). In German.
An extended series of investigations on exo-electron emission
the alkali halides is reported. NaCl and KCl crystals were
ed by X-irradiation and the electron emission glow-curves were
rmined as the sample temperature was increased. It is con-
ed that the process of exo-electron emission is primarily govern-
y the properties of a thin surface layer, rather than being a
me effect, and is attributed to the formation of various types of
ar centre in this surface layer by the excitation treatment.
e is no indication that exo-electron phenomena in the alkali
ies differ in this fundamental mechanism from those in other
tances. A general discussion emphasizes the fact that the
ssion is a surface effect and points out some difficulties in the
ction from the electron emission glow-curves of the activation
gies of the colour centres involved. 32 references.
C.H.B.Mee

ON THE EFFECT OF NITROGEN ON THE EXO-ELEC-
16358 TRON EMISSION OF GERMANIUM. F.Roubínek.
ch. J. Phys., Vol. 10, No. 12, 949-53 (1960). In German.
The exo-electron emission of germanium after X-ray excita-
was studied. Bombardment of the sample with nitrogen ions
re excitation produces an important effect on the form of the
tron emission glow-curve, leading to a pronounced emission
k at about 150°C. It is suggested that nitrogen atoms penetrate
the germanium lattice, becoming trapped at lattice defects and
viding electron donor levels. The thermal emptying of these
els causes the 150°C peak. C.H.B.Mee

THE FIELD EMISSION OF RHODIUM AND IRIDIUM.
16359 D.Stark.
rwissenschaften (Germany), Vol. 48, No. 6, 157 (1961).
erman.
Field emission microscope investigations on single crystals of
dium and iridium are reported briefly. The observations lend
ght to the Stranski theory of crystal growth [Ergebn. exakt.
rwiss., Vol. 26, 383 (1952)]. C.H.B.Mee

ELECTRON EMISSION FROM REVERSE-BIASED P–N
16360 JUNCTIONS IN SiC. L.Patrick.
ppl. Phys. (USA), Vol. 32, No. 10, 2047 (Oct., 1961).
A criticism of some conclusions of Gleichauf and Ozarow
str. 7658 of 1961) on this subject, which invalidates their
ults. J.B.Birks

FIELD AND THERMIONIC EMISSION FROM LAYERS
16361 OF THORIUM AND RADIUM ON TUNGSTEN.
V. Zubenko and I.L.Sokol'skaya.
. tverdogo Tela (USSR), Vol. 3, No. 5, 1561-5 (May, 1961).
Russian.
When barium or thorium are deposited on tungsten in the
ence of oxygen, neither thermionic nor field emission shows the
timum found by earlier workers and ascribed by them to the
perties of monolayers. Emission in fact rises monotonically
thickness of the deposit. From this and other observations,
concluded that the earlier found maximum is caused by oxygen
mically adsorbed on the tungsten surface. [English translation
Soviet Physics–Solid State (USA), Vol. 3, No. 5, 1133-6
., 1961)]. A.E.I. Research Laboratory

FIELD EMISSION OF ELECTRONS FROM A SINGLE
16362 CRYSTAL OF TUNGSTEN PRECEDING THE DEVELOP-
NT OF A VACUUM ARC. G.N.Fursei.
iotekhnika i Elektronika (USSR), Vol. 6, No. 2, 298-302 (Feb.,
1). In Russian.
A description is given of an experiment to test a discrepancy
veen the results of Dyke and his collaborators and Elinson and
collaborators on the one hand and Gofman and his collaborators
he other as to whether the deviation of the voltmeter character-
cs from rectilinearity just before the striking of the arc was
ards lower or higher currents respectively. A deviation towards
er currents was observed but the nonrectilinear part of the
racteristic has a wave form which it is suggested is due to
ntum mechanical effects of interference of electron waves
ected from the potential barrier. J.Berry

THE FATE OF METAL-FILM CATHODES.
16363 N.D.Morhulis.
Ukrayin. fiz. Zh. (USSR), Vol. 3, No. 5, 688-90 (1958).
In Ukrainian.
On the strength of his own experimental work, and for general reasons, the author considers that Nergaard's opinion (Abstr. 1746 of 1958) relating to the fate of various metal films and cathodes is not well founded. F.Lachman

THE INFLUENCE OF OXYGEN AT LOW PRESSURES
16364 ON THE ELECTRIC PROPERTIES OF THE OXIDE CATHODE. N.G.Nakhodkin and G.A.Zȳkov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1436-44 (May, 1961).
In Russian.
Oxide cathodes react with residual gas in the forming process and change their emission properties. The present work studies simultaneously the behaviour of emission, conductivity, and thermo-e.m.f. in the presence of oxygen of known purity at controllable pressures. The experimental results indicate that oxygen is adsorbed on all exposed oxide surfaces and diffuses into the oxide layer some 10^{-4}–10^{-5} cm, changing the concentration of donor centres in each grain and so modifying the electrical properties. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 1042-7 (Nov., 1961)]. A.E.I. Research Laboratory

EMISSION FLUCTUATIONS OF TUNGSTEN-BASED
16365 BARIUM DISPENSER CATHODES. I.Brodie.
J. appl. Phys. (USA), Vol. 32, No. 10, 2039-46 (Oct., 1961).
Emission fluctuations in five different types of tungsten-based barium dispenser cathodes were measured as functions of both frequency and current density. Two of the cathodes were of the L variety and the remainder of the "impregnated" variety. The L cathode spectra show that the emission fluctuations are caused by fluctuations in the number of adsorbed atoms on the tungsten emitting surface. The amplitude of the fluctuations is governed by the average surface coverage and theoretical studies indicate that the shape of the spectra is governed by the diffusion processes by which the surface is replenished. The results from the impregnated cathodes indicate that the contribution of the impregnant in the pore ends to the total noise is only significant when the pore ends supply an appreciable fraction of the total emission from the cathode; the majority of the surface, which is barium activated tungsten, behaves as an L cathode surface.

A METHOD FOR MEASUREMENT OF THE
16366 TEMPERATURE DISTRIBUTION OVER THE SURFACE OF THE PLANE THERMIONIC CATHODES OF VERY SMALL DIMENSIONS. M.Fraçkowiak and A.Taczanowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 4, 255-8 (1960). In French.
The temperature distribution over the surface of small circular thermionic cathodes (diameter 1 mm) was determined to an accuracy of better than ±0.2°C in the range 700-900°C. A photoelectric comparator was calibrated using two nickel cathodes at known temperatures, and was then applied to the cathode under investigation. C.H.B.Mee

COMMENTS ON THE ADMISSIBLE CURRENT LOAD OF
16367 THE OXIDE CATHODE. S.Firkowicz.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 11-12, 655-60 (1960). In German.
A theoretical analysis of the effects of the flow of emission current through a porous oxide cathode coating, taking into account the Joule heating and the cooling due to electron emission, shows that the permissible current load varies inversely with the porosity of the cathode, and increases as the temperature of the cathode increases and as its state of thermionic activation improves. See also following abstract. C.H.B.Mee

CONTRIBUTION TO THE ANALYSIS OF THE ADMISS-
16368 IBLE LOAD OF OXIDE CATHODES. S.Firkowicz.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 11-12, 661-5 (1960). In German.
A theoretical analysis of the dependence of the perveance of a diode on the current passing through the oxide cathode is followed by an account of experiments designed to investigate the effect of the temperature distribution over the surface of the cathode on the permissible load. See also preceding abstract. C.H.B.Mee

16369 INVESTIGATION OF THE PROCESS OF EVAPORATION FROM OXIDE-COATED CATHODES. G.Ya.Pikus.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 736-45 (March, 1961). In Russian.

Substances evaporated from oxide-coated cathodes in vacuo are identified and estimated by accurate mass-spectronetry, allowance being made for the simultaneous presence of products of dissociation attributed to the impact of fast electrons. Barium oxide is found to predominate, but significant amounts of barium, strontium, and even the underlying nickel are observed. The barium contains two components distinguished by their differing volatility. The function of barium and nickel in oxide cathodes is discussed in the light of these experiments. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 536-43 (Sept., 1961)]. A.E.I. Research Laboratory

16370 THEORY OF NON-STATIONARY THERMIONIC EMISSION OF A SEMICONDUCTING CATHODE.
A.A.Ostroukhov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 3-14 (Jan., 1961). In Russian.

Earlier equations for the rise in thermionic emission of semiconducting cathodes with time are reconsidered with special reference to conditions at the beginning and end of a long anode-voltage pulse. The influence of anode voltage and semiconducting parameters on the time dependence of the thermionic current are discussed. Desorption and adsorption of atoms at the cathode surface are related to the magnitude of the current impulse. [English translation in: Soviet Physics—Solid State(USA), Vol. 3, No. 1, 1-8 (July, 1961)]. A.E.I.Research Laboratory

16371 THERMIONIC GENERATION OF ELECTRICITY. M.A.Cayless.
Brit. J. appl. Phys. Vol. 12, No. 9, 433-42 (Sept., 1961).

A thermionic generator of electricity is essentially a diode valve in which electrons emitted from a hot cathode flow to a cooler anode, producing an electric current. From being scientific curiosities, such devices have become the subject of intense research activity in the last three years, and it is now clear that they have considerable possibilities as useful generators in a number of fields. Recent work is reviewed and an assessment is made of the present position and future trends. Although engineering design and applications are considered, the emphasis is on the physical processes associated with these devices, and the progress which has been made into understanding them.

16372 SOME PROPERTIES OF Cs PLASMA IN A THERMIONIC ENERGY CONVERTER.
N.D.Morgulis and Yu.P.Korchevoi.
Dokl. Akad. Nauk SSSR, Vol. 136, No. 2, 336-8 (Jan. 11, 1961). In Russian.

A short report on the characteristics of a discharge in vapour between thorium carbide and tantalum electrodes, investigated by a probe method. Tables and graphs relating the behaviour of typical quantities are given, together with a qualitative discussion of the results. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 1, 71-3 (July, 1961)]. G.Martelli

16373 THEORY OF THE PHOTOELECTRIC EFFECT IN METALS. A.Meessen.
J. Phys. Radium (France), Vol. 22, No. 5, 308-20 (May, 1961). In French.

The photoelectric effect in metals is no longer considered as a surface but a volume effect, determined by the following processes: (1) The penetration of light into the metal film, which is responsible for the inadequacy of measurements of the photoelectric efficiency Y per incident photon. It is preferable to refer to the efficiency Y_a per absorbed photon. (2) The photoexcitation by oblique transitions, which determines the density and energy distribution of the excited electrons. (3) The portion p of excited electrons which move to the surface in a solid angle such that the velocity component normal to the surface allows emission over the potential barrier. This rapidly varying factor determines the spectral distribution near the threshold, especially in the approximation of the Fowler–DuBridge formula. (4) The individual or collective interactions of the excited electrons with the other electrons, which produces absorption or secondary emission of electrons. The experimental electron absorption length thus obtained for K shows that the theory of individual electron interactions needs to be improved. Y and Y_a can be calculated, either taking account of the real energy distribution of the excited electrons, assuming very thin films, or in the monokinetic approximation, considering the influence of light penetration, electron absorption and film thickness. This method is very simple and useful. The very large photoelectric efficiency of metals such as Be in the far ultraviolet is the normal prolongation of the volume effect observed near the threshold.

16374 PHOTO-EMISSION FROM METAL SURFACES MEASURED WITH GEIGER COUNTERS.
M.A.Conrad and S.Levy.
Nature (GB), Vol. 189, 887-9 (March 18, 1961).

Photoelectric emission from mechanically worked and X-irradiated samples of Al, Sn, Cu, Ni and Zn was studied with windowless point counters. No electron emission above the background could be detected when the tubes were shielded from light. This observation suggests that exo-electron emission from worked metal surfaces may, in fact, be due to photoelectric emission induced by stray light. Evidence in favour of this hypothesis is obtained from a comparison of the effect of X-irradiation on emission from metals and non-metals. Non-metals show true exo-electron emission after X-irradiation, even in the dark; metals show no such emission, and the treatment causes a type of photoelectric fatigue, considerably reducing the photosensitivity. In spite of this fatigue effect, the photoelectric thresholds for mechanically worked or X-irradiated metals lie at considerably lower photon energies than do those for the pure metals in vacuo. C.H.B.

16375 PHOTO-STIMULATED EMISSION OF EXO-ELECTRONS FROM ANODE-OXIDIZED LAYERS OF ALUMINIUM.
T.Lewowski.
Acta phys. Polon. (Poland), Vol. 20, No. 2, 161-6 (1961).

It was found that photostimulated emission of exo-electrons can be obtained from Al_2O_3 layers by a.c. anodic oxidation of aluminium or by appropriate thermal processing. The long-wave limit of the photoemission observed lies within the visible spectral region. The method utilized in oxidation of the Al surface was found to affect the intensity of electron emission. The emission is considered to be due to centres resembling the F-centres in alkali halides.

16376 PHOTO-STIMULATED EMISSION OF EXO-ELECTRONS FROM THE SURFACE LAYER OF AMPHOTERIC METALS REACTING WITH SODIUM HYDROXIDE OR POTASSIUM HYDROXIDE. B.Sujak and J.Wawrzyniak.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 463-9 (1961).

When reacting with a thin layer of hydroxide sprayed onto the surface, the amphoteric metals Al, Zn, Sn and Pb were found to emit negative charge carriers into an atmosphere of air, if the reacting surface is simultaneously irradiated with white light (λ_{min} ~3600 A). The intensity versus time graphs of the emission show an increase during the first phase of the experiment and, subsequently, an approximately exponential decrease. The emission observed is related to the momentary shift of the effective long-wave limit of the photoeffect during the reaction, until the wavelengths of the incident light beam are attained. The long-wave limit of this photoeffect is displaced towards shorter wavelenghts as we proceed from Al through Zn and Sn to Pb, i.e. as the affinity of the amphoteric metal for the hydroxide diminishes. The photostimulated chemo-emission of exo-electrons was detected and measured with a point counter and a steering grid, in atmospheric air.

16377 THE EFFECT OF CATHODE SURFACE TREATMENT ON THE SPECTRAL SENSITIVITY OF A PHOTON COUNTER. D.M.Eremin.
Pribory i Tekh. Eksper. (USSR), 1958, No. 3, 76-9 (May-June). In Russian.

The spectral sensitivities of bulk Al and Mg photocathodes are sensitive to the surface treatment of the cathode. Polishing the surface leads to a shift of the photoelectric threshold from the ultraviolet towards the red. Evaporated Al and Mg photocathodes sensitive to visible radiation were prepared under conditions of slow evaporation on to a cooled surface; the sensitivity in the visible may be removed by warming the evaporated film. It is suggested that the enhanced sensitivity in the visible region is due to the presence of amorphous layers, with lower work functions than those of the bulk metals, on the cathode surfaces. [English translation in: Instrum. exper. Tech. (USA), No. 3, 403-6 (May-June, 1 publ. June, 1959)]. C.H.B.

16378 SPECTRAL RESPONE OF ANTIMONY-CAESIUM PHOTOCATHODES.

J Birks and I.H.Munro.

B . J. appl. Phys., Vol. 12, No. 9, 519-22 (Sept., 1961).

Measurements were made of the relative photoelectric tum efficiency $\eta(\lambda)$ of $SbCs_3$ cathodes of photomultipliers with :x and quartz windows, in the range λ = 200-650 mμ. $\eta(\lambda)$ nds on the window transmittance $W(\lambda)$, the cathode absorbance d), the absolute photoelectric quantum efficiency $Q_0(\lambda)$ and the oelectron escape probability $f(\lambda, d)$. Comparison with other has allowed the separation of these factors, yielding, inter the absorption spectrum of $SbCs_3$ down to λ = 220 mμ, and absolute photoelectric threshold curve $Q_0(\lambda)$ plotted against λ. optimum thickness for a thin cathode is d = 200 A. Errors in r published data are noted, and methods of increasing $\eta(\lambda)$ of improving scintillation detectors are discussed.

16379 INFLUENCE OF SURFACE WORKING METHODS ON THE PHOTOELECTRIC EMISSION OF GERMANIUM.

.But.

tverdogo Tela (USSR), Vol. 3, No. 4, 1137-43 (April, 1961).

ussian.

Germanium surfaces treated respectively by electrolytic shing, wet glass polishing, etching in CP4, and etching in xide were examined for photo-emission. The several treat- its produced surface defects and caused certain energy levels in forbidden zone to be filled. This is reflected in the volt–ampere racteristics. The greatest reduction in the work function was ght about by etching in peroxide followed by polishing, and the hanism of this and allied phenomena is discussed. [English islation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, -31 (Oct., 1961)]. A.E.I. Research Laboratory

16380 PROPERTIES OF PHOTOEMISSION FROM INDIUM ARSENIDE.

I.Arsen'eva-Geil' and Van Bao-Kun' [Wang Pao-K'un].

tverdogo Tela (USSR), Vol. 3, No. 5, 1622-3 (May, 1961).

Russian.

For abstract, see Abstr. 13107 of 1961. [English translation in: viet Physics–Solid State (USA), Vol. 3, No. 5, 1176-7 (Nov., 1961)].

16381 COMPENSATION FOR THE EFFECT OF SURFACE CHARGE DURING PHOTOELECTRIC EMISSION FROM SULATORS WITH THE AID OF AN ELECTRONIC CAMERA.

Hartmann.

R. Acad. Sci. (France), Vol. 252, No. 21, 3230-2 (May 24, 1961).

French.

In the study of the spectral distribution of photoelectrons from insulator (Abstr. 7141 of 1960), the disturbance caused by a sitive charge distribution (Abstr. 3003 of 1961) may be overcome depositing a thin conducting film on the opposite surface.

E.R.Wooding

16382 CRYSTAL STRUCTURE OF PHOTOELECTRIC FILMS OF CAESIUM ANTIMONIDE. W.H.McCarroll.

appl. Phys. (USA), Vol. 32, No. 10, 2051-2 (Oct., 1961).

Photocathodes were prepared by treating evaporated antimony vers with caesium to obtain cathodes of maximum sensitivity. r comparison some less sensitive cathodes were prepared with nsitivities ranging from 6-38 μA/lm. The caesium antimonide cathodes of known sensitivity was removed by scraping and bjected to X-ray powder diffraction analysis. All materials amined showed the main lines of a simple body-centred cubic ructure of Cs_3Sb with a lattice constant of 4.56 A. These lines re most intense in the sensitive cathodes, additional lines being ly visible in relatively insensitive cathodes. Changes in the ttern after heat treatment were attributed to reactions in which wer antimonides were formed. W.Steckelmacher

16383 PHOTOELECTRIC MEASUREMENTS ON HIGHLY DISORDERED FILMS OF Sn, Pb and Cd. F.Baumann.

Phys. (Germany), Vol. 163, No. 4, 377-81 (1961). In German.

Thin films of Sn, Pb and Cd were produced by quenching con- nsation at low temperatures. The photoelectric emission and the ectrical resistivity were measured after condensation and during nealing. In the case of Sn and Pb both the electrical resistance d the photoelectric sensitivity decrease during annealing. The sistance of Cd films shows the same behaviour, but the photo- ectric sensitivity decreases only above 90°K.

16384 DEVELOPMENT OF THE MANUFACTURE OF SOME TYPES OF PHOTOMULTIPLIER. E.Morilleau.

Nuclear Electronics Conference, Paris, 1958, Vol. II (see Abstr. 12720 of 1960) p.367-76. In French.

A brief description of the methods of making the glasswork, assembling the components, sealing, pumping, aging and testing, with histograms of photocathode and anode sensitivity distributions.

W.G.Stripp

16385 STUDY OF THE CHARACTERISTICS OF 54 AVP PHOTOMULTIPLIERS IN THE LIGHT OF THEIR USE IN THE DETECTION OF RADIATIVE-CAPTURE γ-RAYS.

P.Ribon, A.Coin, A.Michaudon and H.Nifenecker.

J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 108 A-114 A (June, 1961). In French.

Some neutron cross-sections measured with the Saclay linear accelerator as a neutron spectrometer were obtained by means of a capture γ-ray detector. The operating characteristics of the 54 AVP photomultiplier tubes used in this detector were studied with reference to resolution and gain stability in connection with counting rate, temperature and fatigue effect. A 10% resolution for the 660 keV γ of Cs^{137} was obtained. The lack of photocathode homogeneity appears to be the main obstacle to a better result. The gain shift in terms of the anode current is calculated and compared with experiments. The fatigue effect is shown. The gain variation relative to a temperature change is studied both theoretically and experimentally, taking into account the crystal decay time and the anode integration time constant.

16386 FAST CLIPPED PULSES FROM PHOTOMULTIPLIER TUBES. S.C.Pancholi and N.K.Saha.

Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 263-5 (May 26, 1960).

A simple device was used to obtain clipped pulses of short duration ($\sim 10^{-10}$ to 10^{-11} sec) by mixing the anode and the tenth dynode pulses of an RCA-5819 photomultiplier tube. The single and the clipped pulses were photographed on an oscilloscope and also studied on a diode bridge fast-coincidence circuit.

16387 THE RESPONSIVITY PROFILE OF PHOTO-MULTIPLIERS. H.C.Ingrao and J.M.Pasachoff.

Rev. sci. Instrum. (USA), Vol. 32, No. 7, 866-7 (July, 1961).

Response profiles are obtained by spot scanning opaque and semitransparent photocathodes of photomultipliers. The rather more even response of the EMI-9502B compared with the RCA-931A is ascribed to the sharper electron-optical focusing of the latter tube.

D.Walsh

16388 SIMPLE LIGHT PULSER FOR TESTING PHOTO-MULTIPLIERS. J.R.Prescott and D.L.Lindquist.

Rev. sci. Instrum. (USA), Vol. 32, No. 8, 990 (Aug., 1961).

Describes the use of a subminiature cathode-ray voltage-indicator tube (DM 160) as a pulsed source of light. A rise-time of 1 μsec was measured at the collector of a photomultiplier when pulses with a rise-time of 0.05 μsec were applied to the grid of the DM 160. In the end-on position adopted no measurable increase in noise was obtained. It is suggested that the DM 160 be run off hearing aid batteries, thus forming a compact source.

D.Llanwyn-Jones

PHOTOMULTIPLIER GAIN FLUCTUATIONS. See Abstr. 16073

16389 PHOTOELECTRONIC IMAGE INTENSIFIERS. J.D.McGee.

Rep. Progr. Phys. (GB), Vol. 24, 167-211 (1961).

The limits set to the detectability of an image by the statistical fluctuations resulting from the quantum nature of light are analysed and the efficiency of the photoelectric effect as a detector of optical images is compared with that of the photographic effect. The possible methods of using the photoelectric effect for image detection are enumerated and it is pointed out that this review deals only with those image intensifiers using free electrons. The second section outlines the possible light gain to be had from a simple photocathode–phosphor image tube and gives the reasons for its failure to reach the ideal performance. The methods employed to enable these tubes to be operated at high gain without undue background and to enable the output light to be used efficiently are described. The techniques developed allow the electron image to be projected through a thin window on to a fine grained photographic film external to the tube. The big advantages of this technique are pointed out. The method developed by Lallemand over the years in which the photocathode and photographic emulsion are in the same

vacuum chamber is described and its advantages and disadvantages are enumerated. Then the development of this method is described in which the electron image is projected through a thin film separating the photocathode and photographic plate compartments, the thin film protecting the photocathode from the gas evolved from the photographic emulsion. A single-stage electrostatic focusing image intensifier in which electron-image demagnification is used is described and its operation discussed. The elaboration of this type of image intensifier as an X-ray image intensifier is described. The methods of electron-image multiplication are described in the third section. In these the number of electrons is multiplied by a large factor before they are accelerated and detected. Three methods are described: firstly, the cascaded phosphor–photocathode screen intensifier, secondly, the transmission secondary-emission multiplying screen method, and thirdly, the channelled electron-image multiplier. The problems involved in each of these devices are outlined and the present state of development and performance is summarized. Section 4 deals with methods of positive light feedback from the output image of a simple image tube to the photocathode. The fundamental requirements for this method to work are explained and the methods employing exact registration and non-registration are discussed. In the last section, brief descriptions are given of scientific observational problems in astronomy, nuclear physics, spectroscopy and radiology, in which one or other of the image intensifier tubes described might find useful application.

16390 SINGLE STAGE PHOTOELECTRONIC IMAGE INTENSIFIERS. J.D.McGee and B.E.Wheeler.
J. photogr. Sci. (GB), Vol. 9, No. 2, 106-17 (March-April, 1961).

The limit of image detectability determined by the shot noise of the incident photons is discussed and the sensitivity of the ideal detector is evaluated. The advantages of a photoelectric, as compared with a photographic, primary detector are enumerated and some of the practical methods and problems involved in taking advantage of the greater quantum efficiency of the photoelectric effect are then described. The methods described are limited to single-stage image intensifiers. The first of these is Lallemand's electronic camera in which the electrons from a photocathode are focused at high energy on a photographic plate in the same vacuum chamber. The second is the modified type of the same device in which the vacuum chamber is divided into two compartments by a thin membrane; the photoelectrons being projected through this membrane from the photocathode on the high vacuum side onto the photographic plate in the relatively low vacuum side. Thirdly the method is described in which the electron image is formed on a phosphor screen and the light from this image is recorded on a photographic emulsion. The development of a thin window to enable contact records to be made and the reduction of spurious background are the main points of this development. Lastly, as a result of this work, it has become possible to project the electron image through a very thin mica window and record it directly on a photographic plate in contact with the window.

16391 EMISSION OF ELECTRONS FROM TUNGSTEN BOMBARDED WITH POSITIVE IONS.
N.N.Petrov and A.A.Dorozhkin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 53-60 (Jan., 1961).
In Russian.

Reports a study of secondary emission from a tungsten target bombarded with He^+, Ne^+, A^+, N^+, N_2^+, and Ca^+ ions. The results are used to discuss the effect of the electron structure of ions on electron emission produced by them. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 38-43 (July, 1961)].
A.Tybulewicz

16392 THE THEORY OF ELECTRON EMISSION BY IONS.
E.S.Parilis and L.M.Kishinevskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1219-28 (April, 1961).
In Russian.

After a review of earlier theories, expressions are developed for the transfer of energy from the bombarding ions to the electrons and for the subsequent behaviour of the excited electrons. These to a certain extent undergo Auger recombination. An estimate of the emission in particular cases is made and is found to agree well with experiment. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 885-91 (Oct., 1961)].
A.E.I. Research Laboratory

16393 EFFECT OF MAGNETIC FIELDS UPON REFLEX KLYSTRON CHARACTERISTICS.
M.E.Brodwin and J.W.Davis.
Rev. sci. Instrum. (USA), Vol. 32, No. 2, 223-4 (Feb., 1961).

A magnetic field perpendicular to the direction of beam motion was found to give frequency control in 723 A/B, X-13 a 2K39 klystrons. In the first two the frequency increased with I while in the latter it decreased. The magnitude of the effect va below 200 G it is practically zero and between 400 and 500 G it increases rapidly. The effect may be used for frequency stabil tion. A.H.W.

16394 SCINTILLATION EFFECT IN VALVE SELF-OSCILLATORS. A Blaquière.
C. R. Acad. Sci. (France), Vol. 252, No. 16, 2390-2 (April 17, 1
In French.

The method employed previously for studying the effect of noise in amplitude-stabilized self-oscillators [Abstr. 3387 B of Ann. Radioelect. (France), Vol. 8, 36-80 (Jan., 1953)] is now us study the effect of background noise in the low-frequency range (scintillation noise). J.W.T.W

16395 THE EFFECT OF ELASTICALLY REFLECTED ELECTRONS ON THE CHARACTERISTIC OF A THERMIONIC DIODE. K.H.V.Booth and I.A.Harris.
Proc. Roy. Soc. A (GB), Vol. 261, 134-52 (April 11, 1961).

The effect of the elastic reflection of slow (< 2 eV) electro from the anode and the cathode of a planar diode on the potentia distribution and the voltage/current characteristic is worked o Both the "exponential" and the "space-charge limited" regions the characteristic are treated, and for the exponential region s new ξ-η tables have been computed which include the effect of electron reflection. The characteristic of an actual planar diod is calculated as an example and is compared with the experime determined characteristic. It is concluded that the elastic refl of slow electrons in a diode with an oxide-coated cathode has a major effect on the voltage/current characteristic and the elec field distribution. The determination of contact potential assoc with the diode is also affected.

16396 ESTIMATION OF THE TOTAL EMISSION OF A DI UNDER NORMAL OPERATING CONDITIONS WITH REMOVING THE SPACE-CHARGE. C.S.Bull and R.K.Fitch.
Brit. J. appl. Phys., Vol. 12, No. 10, 566-8 (Oct., 1961).

The total emission of the cathode of a planar diode over a of cathode temperatures was measured in a non-destructive wa detailed examination of the characteristics. A total emission o about 25 A/cm^2 was found for an EA 50 operating at normal cat temperatures. This result was tested by comparing theoretica values of the space-charge smoothing factor calculated from th characteristic curves in two distinct ways, only one of which in the total emission directly. It was found that Richardson's equ for the total emission fails noticeably over the wide range of c temperatures investigated, and that this failure is not explicabl the basis of changes in the cathode work function.

MECHANISM OF THE MULTIPACTOR EFFECT.
See Abstr. 16299

16397 ELECTRON BEAM MODULATION BY MEANS OF THIN LAYER IN A DECELERATING FIELD.
A.Fryszman.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 11-1 647-54 (1960).

A mathematical analysis is carried out, using a simple m of the target current in a pick-up tube of the high-potential type (e.g. iconoscope), taking into account the return of photo and se ary electrons to the target. The dependence of signal current area of illumination and on potential of the illuminated part of target agrees with observation. B.Me

16398 ON E.L.CHU'S DEFINITION OF SMALL SIGNAL R. POWER OF ELECTRON BEAMS.
D.L.Bobroff, H.A.Haus and J.W.Kliiver.
J. appl. Phys. (USA), Vol. 32, No. 4, 749-50 (April, 1961).

This is the authors' reply to Chu's criticism (Abstr. 3453, 3798-9, 5344 of 1960) of their small-signal power theorem (Abs 3173, 8028 of 1958). Contrary to Chu's remarks the authors ha pointed out the value of the theorem in two problems. They hav also pointed out flaws in Chu's treatment of boundary condition thus conclude that his criticisms based on that treatment are n valid. M.S.S

399 CALCULATED ENERGY DISSIPATION DISTRIBUTION IN AIR BY FAST ELECTRONS FROM A GUN SOURCE.
l rew.
s. Nat. Bur. Stand. (USA), Vol. 65A, No. 2, 113-16 (March- . 1960).
tesults of calculations on the energy dissipation distribution ectrons from a point collimated (gun) source in an infinite air im are presented. The calculation is made for a monoenergetic c of 0.4 MeV electrons. The method of moments is employed, ; the two spatial variables separately.

6400 TRANSMISSION CURRENT MONITOR FOR HIGH ENERGY ELECTRON BEAMS.
amuty and B.S.Deaver, Jr.
sci. Instrum. (USA), Vol. 32, No. 10, 1098-1100 (Oct., 1961).
A current monitor suitable for use with continuous or pulsed energy electron beams is described. It functions by collect- low secondary electrons emitted on passage of high energy rons through a thin foil in vacuum. The secondary current is ear function of primary current at average primary currents up least 120 μA (peak current density ~150 mA cm^{-2}), and is ndent of energy at least in the range 6-30 MeV with negligible absorption.

6401 THE WIDENING OF AN ELECTRON BEAM BY THE SPACE CHARGE. M.Boivin.
ys. Radium (France), Vol. 21, Suppl. No. 11, 171 A - 172 A ., 1960). In French.
A recurrence formula for the computation is developed. The ication of this formula has been found to be in agreement with riments made with a 1 MeV electron accelerator.

6402 A PRACTICAL CALCULATION ON THE DEFOCALIZING INFLUENCE OF SPACE CHARGE APPLIED TO CASE OF RELATIVISTIC ELECTRON BEAMS. A.Septier.
ys. Radium (France), Vol. 22, Suppl. No. 6, 79A-82A (June,). In French.
Using the equation of motion of a relativistic particle situated e surface of the beam, formulae and a chart are obtained per- ing the calculation for any initial conditions of the radius of the n at a point on the axis of a drift space. The method is applied ectron beams of 2 and 100 MeV.

6403 ELECTROMAGNETIC AND SPACE CHARGE WAVES IN A SHEATH HELIX. S.Olving.
mers Tekn. Hogsk. Handl. (Sweden), No. 225, 88 pp. (1960).
The electromagnetic interaction between a sheath helix and an tron beam is investigated theoretically. The whole doubly ite set of space charge waves is included and approximate ressions for their propagation constant are derived. The valid- nd properties of these expressions are analysed. Only the first r (i.e. dominant) slow space charge wave is amplified in the em while higher order waves, which propagate with constant litude, show certain transformation properties. The analysis shows that previous theories fail near the low electron velocity of the amplification region. The velocity bandwidth of travelling e tubes is considerably wider than these theories indicate.

6404 THE GENERAL INTENSITY DISTRIBUTION IN THE NEIGHBOURHOOD OF A CAUSTIC SURFACE COHERLY ILLUMINATED. F.Lenz and E.Krimmel.
hys. (Germany), Vol. 163, No. 3, 356-62 (1961). In German.
It is found that in the case of coherent radiation the intensity ribution in the near vicinity of any regular caustic surface is ribed by the same Airy integral. The scale in which the dis- e of intensity maxima and minima is measured depends only on wavelength and the difference of the curvatures of the tangent tron ray and the circle of curvature to which this ray is tangent. s result is confirmed by a simple light optical experiment. For case of a charged particle in a homogeneous field the result of rect wave-mechanical calculation is in agreement with the above roximation, in which some concepts of geometrical optics have n used.

16405 THE GUIDING CENTER APPROXIMATION TO CHARGED PARTICLE MOTION. T.G.Northrop.
n. Phys. (USA), Vol. 15, No. 1, 79-101 (July, 1961).
The equations governing the guiding centre motion of a rged particle in an electromagnetic field are obtained simul- eously and deductively, without considering individually the cial geometric situations in which one effect or another occurs ne. The general expression is derived for the guiding centre velocity at right angles to the magnetic field B. This expression contains five terms arising in the presence of an electric field. They are in addition to the usual "E × B" drift. Because these terms are unfamiliar objects in the literature on plasmas, they are illustrated by simple examples. Three of the five drifts occur in rotating plasma machines of the Ixion type. One of these three is also shown to be responsible for the Helmholtz instability of a plasma. A fourth one gives the (low frequency) dielectric constant, while the fifth arises if the direction of B is time dependent. A detailed geometric picture of the fifth drift is given. The equation governing the guiding centre motion parallel to B is also derived for the general time-dependent field. The conditions are discussed under which it can be integrated into the form of an energy integral. Finally the component of current density perpendicular to B in a collisionless plasma is shown to be the current due to the guiding centre drift plus the perpendicular component of the curl of the magnetic moment per unit volume. Proofs of this have been given in the past for special cases, such as static fields, $\nabla \times B = 0$, etc. This proof holds in general, provided conditions for adiabaticity are met. It is also true, but not proven in this paper, that the component of the current density parallel to B is the current due to the guiding centre velocity parallel to B plus the parallel component of the curl of the magnetic moment per unit volume. A proper proof of the parallel component is quite lengthy.

16406 THE INSTABILITY OF ELECTRON BEAMS IN CROSSED FIELDS IN PRESENCE OF AN OBLIQUELY PROPAGATED DISTURBANCE. B.Glance and G.Mourier.
C. R. Acad. Sci. (France), Vol. 252, No. 17, 2532-3 (April 24, 1961). In French.
The investigations of Epsztein (Abstr. 5143 of 1956), who studied a uniform periodic perturbation, were extended to the case of a periodic but non-uniform variation in thin plane electron beams travelling in a direction perpendicular to orthogonally crossed electric and magnetic fields. It is found that only those modulations are appreciably amplified which have a slow variation in the direction of the magnetic field. The result is of interest for the discussion of noise in this type of electron tube. V.E.Cosslett

16407 STUDY OF ERRORS IN THE NUMERICAL INTEGRATION OF PARAXIAL TRAJECTORIES IN ELECTRON OPTICS FOR ROTATIONALLY SYMMETRIC SYSTEMS.
R.Lapeyre.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3431-3 (May 29, 1961). In French.
Numerical solution of the ray equation by the Runge—Kutta method leads to progressive errors. Formulae for these errors are established, and are found to be highly accurate when tested in a case for which an exact solution is available.
A.E.I.Research Laboratory

16408 THE METHOD OF RETARDATION CURVES WITH THE USE OF AN INTERMEDIATE ACCELERATING GRID.
V.Orlinov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1211-18 (April, 1961). In Russian.
Retardation potential curves, giving the dependence of anode current on anode voltage in the presence of an accelerating grid, are often used to determine ion velocities, electron temperatures, and work functions of thermionic emitters. The underlying electron-optical theory, usually omitted, is here given in detail, several small but necessary corrective terms being brought to light. An experimental check of the theory is proposed. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 880-4 (Oct., 1961)]. A.E.I. Research Laboratory

16409 A METHOD OF INJECTING CHARGED PARTICLES INTO A MAGNETIC FIELD. E.M.Moroz.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 16-17 (Jan.-Feb.). In Russian.
An approximate theoretical discussion of the following injection process is given. A bunch of charged particles is injected into a toroidal channel in a dielectric, or a waveguide containing metal diaphragms. The particles lose energy by Cherenkov emission, the orbit contracts, and the bunch misses the injection system. Owing to the continuous energy loss, the particles ultimately leave the channel, the Cherenkov emission terminates, and a stable orbit is reached. This method is said to be suitable for electron storage systems at a few MeV. S.Chomet

16410 REMARKS ON THE ADIABATIC INVARIANCE OF THE ORBITAL MOMENTUM OF CHARGED PARTICLES.
G.Backus, A.Lenard and R.Kulsrud.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 1007-9 (Nov., 1960). In German.

An earlier calculation of this quantity by Hertweck and Schülter (Abstr. 9867 of 1959) involved an approximation which could not be justified. The authors now show that for a limited class of problems an exact solution can be obtained and they find that the earlier calculation contains errors of the same order as the quantity sought. A.E.I.Research Laboratory

16411 IMPROVED ELECTRON GUN FOR ZONE-MELTING BOMBARDMENT. M.Cole, C.Fisher and I.A.Bucklow.
Brit. J. appl. Phys., Vol. 12, No. 10, 577-8 (Oct., 1961).

A simple electron focusing device for floating-zone electron-bombardment furnaces is described. The filament is surrounded by and electrically connected to a water-cooled copper cage, which focuses the electron beam some 3 cm vertically below the filament. The anode is thus largely protected from evaporation from the filament, the molten zone is not obscured and evaporation and sputtering from the zone do not contaminate the filament. The sharpness of the focused beam may be altered by varying the filament diameter and position. Rods of between 3 mm and 12 mm diameter were successfully zoned in a cage of the dimensions given.

16412 CALCULATION OF THE SPHERICAL ABERRATION OF QUADRUPOLE ELECTROSTATIC LENSES. A.Septier.
C. R. Acad. Sci. (France), Vol. 42, No. 19, 2851-3 (May 8, 1961). In French.

Expressions are derived for symmetrically and dissymmetrically excited quadrupoles enabling the calculation of perturbed trajectories and values of spherical aberration to be made. The agreement of such calculations with experimental results is good. V.R.Switsur.

16413 ELECTRON INTERFERENCE IN THE NEIGHBOURHOOD OF THE CAUSTIC CURVE OF A MAGNETIC QUADRUPOLE LENS. E.Krimmel.
Z. Phys. (Germany), Vol. 163, No. 3, 339-55 (1961). In German.

It is shown that a coherent superposition of parts of an electron wave field by magnetic fields is possible. The deflecting magnetic fields are formed by a quadrupole lens. The interference space in which the coherent superposition of three partial waves takes place is limited by a caustic surface. The interference phenomena in the neighbourhood of this surface can be described by means of an integral of the Airy type. A quadrupole lens with rectangular pole piece edges forms at great distances from its axis homogeneous magnetic fields of opposite direction. If a coherent irradiation by both of these homogeneous fields can be achieved, they form a magnetic biprism if the paraxial part of the beam is stopped. The distance of interference fringes in such an interferogram would be independent of the particle energy to a first approximation.

16414 FRESNEL DIFFRACTION AT THE EDGE OF A SCREEN: CASE OF A SMALL ERROR IN FOCUSING IN ELECTRON MICROSCOPY. C.Fert and A.Laffitte.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3213-15 (May 24, 1961). In French.

Shows that the discrepancy between the observed spacing of Fresnel fringes in the electron microscope and that of simple optical theory can be explained if it is assumed that the edge is not perfectly sharp but contains a transition zone of smaller thickness. This zone although important is too small to be easily observed directly. A.E.I. Research Laboratory

16415 SOME OBSERVATIONS ON THE FORMATION OF THE IMAGE IN ELECTRON MICROSCOPY.
M.Fagot, J.Ferré and C.Fert.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3766-8 (June 12, 1961). In French.

A periodic biological specimen was examined by electron interference. The fringes obtained showed that much of the radiation retained its coherence after passage through the specimen. Resolution was of the same order as that found in normal electron microscopy. A further series of photographs show the effect of defocussing. A.E.I.Research Laboratory

16416 AN ANALYSIS OF METHODS OF ALIGNING MAGNETIC ELECTRON MICROSCOPES. Yu.V.Vorob'ev.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 257-64 (Feb., 1961). In Russian.

A method is proposed for the direct measurement of the distance by which the magnetic fields of dispersion of the lenses s the axis of the objective. An appropriate expression is derive is shown that magnetic alignment of the objective can be emp only within restricted limits and that with this method of alig additional chromatic aberration appears. [English translatio Optics and Spectrosc. (USA), Vol. 10, No. 2, 128-32 (Feb., 196

16417 THREE-BEAM ELECTRON INTERFERENCE WI ELECTROSTATIC BIPRISMS. R.Buhl.
Naturwissenschaften (Germany), Vol. 48, No. 8, 298-9 (1961). In German.

A three-beam electron interferometer was made by modi the electron interference system previously described (Abstr 12828 of 1959). Two electrostatic biprisms are employed, the second being slightly shifted off the optic axis defined by the positions of the electron source and the first biprism. Illustr are given of the appearance of the interference patterns obtai in the Gaussian image plane of the source (A-plane) and in the B-plane, where fringes of equal intensity are formed, in the s way as in the optical three-beam interferometer. The positio the B-plane is sharply critical and may be used for very accu path-length determinations. Thus the three-beam system sho allow more accurate measurements of the electron-optical refractive index of foils than does the two-beam system. V.E.C

16418 METHOD OF COMPENSATING ALTERNATING MAGNETIC FIELDS IN ELECTRON INTERFEROMETERS. R.Buhl.
Z. angew. Phys. (Germany), Vol. 13, No. 5, 232-5 (May, 1961). In German.

Two fully automatic methods are described for compensa the effects on electron beams of alternating magnetic fields d the 50-cycles mains supply. The chief trouble in the electron interferometer has been the field due to the connection of the null lead of the three-phase supply to other earthed conductor Examples are shown of the improvement obtained in the inter ference fringes in a wide-angle two-beam electron interferom (Möllenstedt, Proceedings of the European Regional Conferenc on Electron Microscopy, Delft, 1960, p. 15) by the use of these compensating methods. V.E.C

16419 REFLECTION OF AN ELECTRON BEAM FROM H FREQUENCY FIELDS. R.B.Hall and S.C.Brown.
J. appl. Phys. (USA), Vol. 32, No. 10, 1835-6 (Oct., 1961).

Experimental verification of time-average forces due to a field acting on charged particles is obtained by measuring the mission of an electron beam through the high-frequency fields cavity. By adjusting the external d.c. magnetic field so that c tron resonance is approached, it is possible to reflect high-en beams; e.g. 66 W of microwave power completely reflected a beam. Agreement between experiment and theory was close.

16420 "ANOMALOUS" ELECTRON DOUBLE DIFFRACTI O.Haase and R.D.Heidenreich.
J. appl. Phys. (USA), Vol. 32, No. 10, 1840-3 (Oct., 1961).

Double diffraction of electrons by tandem foils of polycrys MgO and single crystal silicon is demonstrated. The patterns very similar, irrespective of which foil the electrons pass thr first. The effect is attributed to elastic bending of the thin, si crystal. The relationship between the double diffraction featu Kikuchi lines and angular distortion of the crystal is discusse

16421 ENERGY ANALYSIS OF ELECTRON DIFFRACTIO PATTERNS. H.Watanabe.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2368-9 (Dec., 1960).

Energy loss spectra were obtained for the direct beam an a number of the diffracted beams in the electron diffraction patterns of some single crystals, evaporated Al and Au and smoke particles of ZnO and MgO. A reducing electron lens projects the diffraction pattern on to the slit of a Möllenstedt velocity analyser (Abstr. 5038 of 1950). This method avoids s of the ambiguities in the selected area diffraction measureme of Leonhard (Abstr. 1892 of 1955). An electron spot size of ab 0.1 mm is used and an accelerating voltage of 30 kV. In single crystals it is found, both in reflection and transmission, that inelastic scattering occurs to a large extent in the directions the diffracted beams as well as in the incident direction. Elas scattering is very weak in directions which do not satisfy a Bragg condition. In smoke particles, on the other hand, inelas scattering occurs almost entirely in the incident direction an considerable elastic diffuse scattering occurs around the elec

In evaporated metals, inelastic scattering takes place in the acted beams, as in single crystals, but much diffuse elastic tering occurs also. V.E.Cosslett

6422 ELECTRON WAVE DIFFRACTION AT MAGNETIC STRUCTURES.
ersch, H.Hamisch, D.Wohlleben and K.Grohmann.
hys. (Germany), Vol. 164, No. 1, 55-8 (1961). In German.
Magnetic fields represent phase objects for electron waves, at h diffraction can take place. The diffraction pattern arising id an object with a weakly deflecting magnetic field is deter-d using Kirchhoff's formula.

6423 DIRECT MEASUREMENT OF THE RADIAL CURRENT DENSITY DISTRIBUTION IN THE DEBYE–SCHERRER CTRON CONE FROM THIN FILMS. G.Behrens.
hys. (Germany), Vol. 162, No. 2, 180-202 (1961). In German.
An apparatus is described in which measurements can be e with a Faraday cage of the angular distribution in the electron action pattern from a thin film. No electron lenses act on the n after it has passed through the specimen, and special autions are taken to eliminate electrons scattered from internal s of the apparatus. The method is claimed to be more accurate ~ 1%) than that of previous investigators. In particular, the astically scattered component is found to be much smaller previously reported. Sequential measurements were made llow the initial degradation of organic films in an electron n at 52.5 kV and the subsequent growth of carbonaceous amination. By measurements at 56 kV on aluminium films ifferent thicknesses, it was shown that scattering power is portional to film thickness for sufficiently thin films. A parison was made between measured intensities of diffraction s and the values predicted by kinematic theory, using an roved evaluation procedure, and good agreement was obtained.
V.E.Cosslett

6424 MEASUREMENTS ON COLLISION FREQUENCIES OF ELECTRONS IN NEON GAS. T.Dodo.
hys. Soc. Japan, Vol. 16, No. 2, 346 (Feb., 1961).
Measurements of the collision frequency for momentum transfer were made by the cyclotron resonance method. The results can xpressed as $\nu_m = 7.3 \times 10^8 p$ where p is the pressure in mm Hg, ections being made for the increase in electron temperature p is less than 4 mm Hg. The results are insensitive to the tron density, suggesting that only electron–neutral collisions are nportance. M.R.C.McDowell

.6425 EFFECTIVE CROSS-SECTION AND ANGULAR DISTRIBUTION OF ELASTIC AND INELASTIC CTRON SCATTERING IN ALUMINIUM FOILS.
orstmann and G.Meyer.
hys. (Germany), Vol. 164, No. 1, 21-39 (1961). In German.
The absolute intensity of the electrons scattered by a poly-talline aluminium foil was measured in the energy range veen 25 and 50 keV. The electrons scattered elastically were arated from those scattered inelastically by a retarding field. intensities of the electrons which passed through the foil cattered, and of those scattered elastically into the Debye–errer-rings and into the continuous background, can be inter-ted by assuming reasonable thicknesses for the crystalline minium and the amorphous aluminium oxide. These values agree roximately with the thickness as measured by light absorption. inelastic scattering probability can also be deduced from these surements. The angular distribution was investigated to study influence of inelastic scattering on the shape of the primary m, the rings and the continuous background. The results are ussed in detail. Some particular results are given concerning increase in half-width of the rings due to inelastic scattering.

16426 THE PRODUCTION AND DEMONSTRATION OF POLARIZED ELECTRON BEAMS BY DOUBLE TTERING OF LOW ENERGY GLOW ELECTRONS (1-2 keV) F ATOMIC BEAMS OF MERCURY. H.Deichsel.
Phys. (Germany), Vol. 164, No. 2, 156-65 (1961). In German.
A maximum intensity asymmetry of 200 ± 31 ± 5 was erved for double 90° scattering of 1500 eV electrons.

16427 EXPERIMENTAL DETECTION OF TRANSITION RADIATION. H.Boersch, C.Radeloff and G.Sauerbrey.
s. Rev. Letters (USA), Vol. 7, No. 2, 52-4 (July 15, 1961).
The Lilienfeld radiation from clean surfaces of a number of als irradiated with electrons of energy 2-12 keV was observed its spectrum analysed. It is concluded that this radiation is the same as the transition radiation and is not a part of the brems-strahlung or a plasma radiation. W.G.Townsend

ION EMISSION . ION BEAMS

WORK FUNCTION OF THE GOLD–BARIUM SYSTEM.
See Abstr. 15174

16428 ION SOURCES EXCITED BY HIGH-FREQUENCY OSCILLATORS. D.Blanc and A.Degeilh.
J. Phys. Radium (France), Vol. 22, No. 4, 230-46 (April, 1961). In French.
H. F. sources give high currents of positive ions and are of current use in particle accelerators, ion microscopes and thermo-nuclear apparatus. Producing nearly monoenergetic ions, they are of value for mass spectroscopy. The papers about them, rather numerous, are related to very different matters, so that the data on these sources are often found in a more general study. A synthesis of this rather varied material is considered useful to establish the conditions of the practical use of these sources. The usual models of h. f. sources are described and classified according to the mechanism of the discharge (annular, linear, with or without the application of a constant magnetic field). The principal ion extraction systems are discussed and the various parameters reviewed influencing the intensity of the extracted stream. The average ion energy, and the dispersion around it, are given.

16429 A NEW TYPE OF IONIC SOURCE. J.Habanec.
Czech.J. Phys., Vol. 11, No. 3, 223-4 (Sept., 1961).
Describes a gridded source for use with a cyclotron with better gas efficiency than usual. The ionization was increased by connecting a tuned high frequency circuit to the discharge path; the Barkhausen oscillations produced increased the amplitude of the oscillation of the electrons in the source. J.W.Sturgess

16430 MASS SPECTRUM OF ARGON AT RAISED PRESSURE IN THE ION SOURCE. A.Bloch.
J. Chim. phys. (France), Vol. 58, No. 3, 289-91 (March, 1961). In French.
Mass spectra of ions produced in argon at pressures up to 10^{-2} mm Hg show evidence for the existence of A_2^+, charge transfer in ion–molecule collisions, and probably an auto-ionization from an ion in an excited state. M.R.C.McDowell

16431 HIGH-FREQUENCY ION SOURCE WITH DISCHARGE TAKING PLACE IN SALT VAPOURS.
V.F.Kozlov, V.L.Marchenko and Ya.M.Vogel'.
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 25-8 (Jan.-Feb.). In Russian.
The salt is placed in an elongated quartz container in which it is vapourized by an external heater. A high-frequency discharge is then excited by a coil wound on the container, and the ions are extracted by a system of electrodes through a side port. The source was used with NaCl and $NiCl_2$ as the working substances. Ion currents up to about 1 mA were obtained. Under optimum conditions the extracted beam contained up to 90% of atomic ions of the metal.
S.Chomet

16432 MASS-SPECTROGRAPHIC AND SPECTROSCOPIC STUDIES OF HYDROGEN DISCHARGE FROM AN ION SOURCE.
A.I.Nastyukha, A.R.Striganov, I.I.Afanas'ev, L.N.Mikhailov and M.N.Oganov.
Atomnaya Energiya (USSR), Vol. 8, 44, (1960). In Russian.
English translation in: Plasma Phys–Accelerators–Thermo-nuclear Res. (GB), Vol. 3, No. 3, 218-20 (July, 1961).
Mass spectrographic studies were supplemented by optical spectroscopic methods to study the relative H^+ and H_2^+ ion densities in a slit ion source and also the relative densities in the discharge plasma of the neutral particles H and H_2. Experiments indicated that the degree of dissociation and the H^+ and H_2^+ ion yields from the source differed markedly depending on whether gas was fed into the cathode region or alternatively into the discharge channel. The most important parameters were gas feed rates, discharge voltage and current for which experimental results were obtained. A higher proton yield was observed when gas was fed into the discharge channel. W.Steckelmacher

16433 LITHIUM ION SOURCES.
K.Allison and M.Kamegai.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1090-2 (Oct., 1961).

The preparation of artificial β-eucryptite ($Li_2O\ Al_2O_3\ 2SiO_2$) as a filament coating for the emission of Li^+ ions is discussed. Two ion sources with their initial focusing gaps are described.

SURFACE-IONIZATION ION SOURCE FOR THE SEPARATION OF ISOTOPES OF ALKALI METALS. See Abstr. 13975

16434 RAPID PULSATION DEVICE FOR AN ELECTROSTATIC LOW-ENERGY ACCELERATOR.
B.Cheynier, J.L.Leroy and K.Prelec.
J. Phys. Radium (France), Vol. 21, No. 5, 393-6 (May, 1960).
In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The pulsation is operated on the ion beam obtained from a 300 keV Cockroft-Walton accelerator. After magnetic analysis, it is swept by a transverse radiofrequency electric field, and then chopped by a slit placed after this field. The emerging ion pulse is bunched by an axial radiofrequency electric field. The duration of the ion pulse on the target is a few 10^{-9} s. for a 6.8 Mc/s frequency; the mean current on the target is then 1/5 to 1/6 of the current in the absence of pulsation.

INVARIANCE OF THE ORBITAL MOMENTUM OF CHARGED PARTICLES. See Abstr. 16410

A METHOD OF INJECTING CHARGED PARTICLES INTO A MAGNETIC FIELD. See Abstr. 16409

THE GUIDING CENTRE APPROXIMATION TO CHARGED PARTICLE MOTION. See Abstr. 16405

16435 ELECTROSTATIC FIELD CORRECTION USING TAPERED ROSE SHIMS. L.A.Dietz.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 859-60 (July, 1961).

It is shown that the required thickness of a rectangular shim, used for improving field uniformity in a mass spectrometer electrostatic analyser (Abstr. 19792 of 1960), can be considerably greater than that predicted by Rose's theory, developed for the magnetic case and assuming no field shielding beyond the physical boundary of the analyser gap; a tapered shim causes less field distortion near the boundary than a rectangular one.

I.C.Demetsopoullos

16436 AN OMEGATRON MASS SPECTROMETER AND ITS CHARACTERISTICS. A.Klopfer and W.Schmidt.
Vacuum (GB), Vol. 10, No. 5, 363-72 (Nov., 1960).

An omegatron with noble-metal electrodes is described, which can be given a constant sensitivity to within 10% by the application of a suitable electrostatic field. The sensitivity is not even affected by the action of corrosive gases and vapours, such as H_2O, CO_2 and CH_4, over long periods, and is reproducible from omegatron to omegatron as long as the dimensions are kept constant. A comparison of the ionization probability given in the literature with that calculated from the calibration curve of the omegatron shows that nearly all the resonance ions formed by the electron beam reach the ion collector. The adjustment of the operating data, needed to achieve this condition is in general independent of the mass. Some characteristics of the omegatron are described.

16437 ION MOVEMENTS IN AN OMEGATRON.
G.Schuchhardt.
Vacuum (GB), Vol. 10, No. 5, 373-6 (Nov., 1960).

The motion of resonant ions in the omegatron, already described in the preceding abstract, is investigated. It is demonstrated that the auxiliary electrostatic field in this type of omegatron creates conditions which make for optimum collection of the resonant ions and insure consistent reproducibility. Space-charge effects are estimated, and an expression is derived for the resolving power.

16438 AN OMEGATRON SPECTROMETER, ITS CHARACTERISTICS AND APPLICATION.
E.J.Zdanuk, R.Bierig, L.G.Rubin and S.P.Wolsky.
Vacuum (GB), Vol. 10, No. 5, 382-9 (Nov., 1960).

The development of an omegatron mass spectrometer as a relatively inexpensive and automatic scanning analyser is described. Operating characteristics of the device in the pre range 10^{-8} to 10^{-9} torr are given. Areas of application in whi omegatron is especially suitable are indicated.

16439 EMISSION CONTROL FOR THE OMEGATRON-TY MASS SPECTROMETER. G.R.Giedd and G.C.Rob
J. sci. Instrum. (GB), Vol. 38, No. 9, 361-2 (Sept., 1961).

The basic circuit usually used with the omegatron provid method of regulating filament emission to maintain constant t or beam current. In operation, the basic circuit permits emi current variations of as much as ±40%, together with long ter electrometer zero drift of ±15%, at an input impedance of 10^{1} A circuit of the type used for emission regulation of ion gauge modified to provide closed loop feedback control of omegatron filament emission. Use of this circuit, which monitors and co the target current, results in emission control of ±3% and rec long term electrometer zero drift to ±5%.

A MASS SPECTROMETER FOR IONIZATION EFFICIENC STUDIES USING AN ELECTRON VELOCITY SELECTOR. See Abstr. 16256

16440 ON MULTIPLE SCATTERING CORRECTIONS FO COLLIMATORS. P.C.Hemmer.
K. Norske Vidensk. Selsk. Forhandl. (Norway), Vol. 33, No. 1 79-82 (1960; publ. 1961).

Derives an approximate correction for particles which e collimator walls and are scattered out again some time later. causes the effective width to be greater than the geometrical J.W.St

16441 ENERGY DISSIPATION BY IONS IN THE keV REG J.Lindhard and M.Scharff.
Phys. Rev. (USA), Vol. 124, No. 1, 128-30 (Oct. 1, 1961).

At low energies ionic collisions with atoms are largely el Simple theoretical approximations to scattering cross-sectio ranges and straggling are derived for power potentials, showi that the scattering is peaked in the forward direction rather t isotropic. Using an approximate universal potential of Thoma Fermi type a natural measure of range, ρ, and of energy, ϵ, i obtained for all ions in all substances. The corresponding ra energy curve is computed. At higher ion energies the electro excitation becomes increasingly important. An approximate formula is given for the electronic stopping contribution, incr proportional to ion velocity at low and moderate velocities. T results are applied in the interpretation of a few isotope effec observed in range measurements.

16442 CATHODE SPUTTERING IN INERT-GAS GLOW DISCHARGES. B.J.Stocker.
Brit. J. appl. Phys., Vol. 12, No. 9, 465-8 (Sept., 1961).

Measurements were made of the rate of deposition of spu ed molybdenum films in the abnormal glow discharge in inert gases over the pressure range 3-21 mm Hg, as a function of t gas pressure p and the current i through the discharge tube. rate of sputtering was found to be proportional to $(i/p)^{2\cdot8}$ in bo neon and the Penning mixture 99% neon-1% argon. In helium sputtering was negligible, but the addition of only a trace of n caused appreciable sputtering to occur.

PARTICLE ACCELERATORS

16443 EXPERIENCES WITH THE 4 MV SYMMETRICAL CASCADE GENERATOR AT THE PHYSICAL INSTITUTE OF THE UNIVERSITY OF BASEL.
R.Galli, E.Baumgartner and P.Huber.
Helv. phys. Acta (Switzerland), Vol. 34, No. 4, 352-8 (1961).
In German.

Describes the construction and operation of the machine. Discusses the limitations caused by electrical loading and th effects and origin of the X-radiation and electrons. Difficult found in ageing in a new tube; flashovers caused damage to th electrode surfaces, limiting the maximum voltage. Improver was obtained by coupling the tube to the condenser stack by a LR network. J.W.St

3444 ELECTRON LINEAR ACCELERATOR AS A SOURCE OF INTENSE SECONDARY PARTICLE BEAMS.
amoto.
ys. Soc. Japan, Vol. 16, No. 1, 120 (Jan., 1961).
The efficiency of an electron linear accelerator as a source of (photoproduction by the electron bremstrahlung) is dered and it is concluded that a 760 MeV accelerator with a current of 100 μA could produce pions with an intensity an : of magnitude greater than that achieved at present by irocyclotrons. J.L.Redding

6445 A 500 kV ION ACCELERATOR.
M.Cevolani, S.Petralia, B.Righini, U.Valdré and nturini.
o Cimento Suppl. (Italy), Vol. 16, No. 2, 168-83 (1960).
lian.
)escribes a Cockroft and Walton ion accelerator of 500 kV for roduction of neutrons through the reactions D(d, n)He^3, n)He^4, and of γ-rays from the reaction Li^7(p, γ)Be^8. acteristics of the ion source employed are given: it is of the frequency type with magnetic field and produces ion beams of than 3 mA intensity. The maximum current observed on the erator reaction target is 1.4 mA. Results are also given of urements made on the X-radiation emitted by the accelerator, n the neutrons produced by the action of deuterons on tritium conium.

3446 500 kW PULSE MODULATOR FOR ACCELERATOR APPLICATIONS. G.W.Wheeler.
sci. Instrum. (USA), Vol. 32, No. 10, 1130-1 (Oct., 1961).
A pulse modulator was designed for use with the r.f. system of ale heavy ion accelerator. This unit combines the features of rogen thyratron with the versatility of a hard tube in a m of relatively low cost. The pulse has a rise time less than ec and a duration which is variable up to 3.5 msec. A pulse of V at 60 A can be obtained with a duty cycle of 3.5%.

COCKCROFT–WALTON TYPE NEUTRON GENERATOR.
Abstr. 13453

CALIBRATION OF THE BUCHNER SPECTROMETER OF THE NENBOURG VAN DE GRAAFF. See Abstr. 13701

3447 ENERGY LOSSES IN THE F.F.A.G. ACCELERATOR.
J.Biersack.
gew. Phys. (Germany), Vol. 13, No. 5, 223-4 (May, 1961). In lan.
The electromagnetic radiation losses from a particle in a circular orbit are calculated with special reference to type celerator using fixed field alternating gradient (F.F.A.G.) results can be related to circular accelerators by means of table "machine factor". A.E.I.Research Laboratory

3448 HIGH FREQUENCY BEAM STACKING IN A CYCLIC ACCELERATOR. A.N.Lebedev.
naya Energiya (USSR), Vol. 9, 189 (1960). In Russian.
ish translation in: Plasma Phys–Accelerators–Thermo- ear Res. (GB), Vol. 3, No. 3, 209-12 (July, 1961).
When working out the theory of high frequency beam stacking celerators operating with a constant magnetic field it is rtant to take into account the perturbations of the beam which lready been stacked caused by later acceleration cycles. The effect of these perturbations is to increase the energy spread e beam and to alter its mean energy. This paper presents a ral formulation of this problem and a solution is given for lin particular cases.

3449 ACCELERATORS WITH A GENERAL MAGNETIC FIELD. G.Parzen.
Phys. (USA), Vol. 15, No. 1, 22-43 (July, 1961).
The linear motion of a particle moving in an accelerator ng a general magnetic field is investigated. A solution is found h is valid for a wide class of accelerators, which includes AG synchrotron, FFAG accelerators and the fixed-frequency otron. Results are given for the equilibrium orbit, the betatron lation frequencies, the betatron oscillations and other linear properties.

16450 BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A GENERAL FIELD. II. J.Teichman.
Czech. J. Phys., Vol. 10, No. 10, 722-36 (1960). In Russian.
For Pt I see Abstr. 12659 of 1960. In this second part of the theory of an accelerator with a generalized field, the author solves the dynamics of particles in a stationary approximation (without acceleration). The trajectories of the particles in the neighbourhood of the equilibrium orbit are related to it as betatron oscillations. An analysis of betatron oscillations includes the region of stability determined by means of Routh–Hurwitz criterion, damping, resonance effects and field pertuebations. A general matrix method is presented permitting the inclusion of all the focusing structures used in accelerators.

16451 A REMARK ON BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A GENERALIZED FIELD.
J.Teichmann.
Czech. J. Phys., Vol. 11, No. 7, 476-81 (1961). In Russian.
Discusses the stability region for a canonical system of equations of motion describing the behaviour of a particle in an accelerator with a generalized field, defined on the general rotation surface. The stability region is determined in the plane of two invariants.

16452 BUNCHING PHENOMENA DURING ELECTRON INJECTION INTO THE BETATRON. I. EXPERIMENTS. M.Seidl
Czech. J. Phys., Vol. 11, No. 6, 390-405 (1961).
Under favourable conditions electrons injected into the betatron give rise to high-frequency oscillations. An experimental investigation of the properties of the oscillations is presented, in which new experimental material is added to an earlier paper (1959) and the hypothesis regarding the nature of the oscillations is corrected. The oscillations are due to azimuthal bunching of the injected or captured electrons. The bunching is caused by a regenerative amplification of space-charge density fluctuations. The amplification is produced by the "negative mass instability" mechanism theoeretically investigated by Nielsen, Sessler and Symon (1959) and Kolomenskij and Lebedev (1959). Bunching of the injected electrons is the primary cause of the capture of electrons injected into a static or slowly varying magnetic field. Bunching of the captured electrons represents a limitation in the magnitude of the capturable charge.

16453 AN ELECTROSTATIC METHOD OF EXTRACTING ELECTRONS FROM A BETATRON.
A.A.Borob'ev and B.A.Kononov.
Atomnaya Energiya (USSR), Vol. 7, 487 (1959). In Russian. English translation in: Plasma Phys.–Accelerators–Thermonuclear Res. (GB), Vol. 3, No. 3, 217-18 (July, 1961).
Describes the electrostatic deflection system used on the 15 MeV betatron at Tomsk. A deflection voltage of 40 kV was applied as a pulse to avoid the difficulty of leakage field which would stop the capture of electrons at injection. Extraction efficiencies of up to 80% are possible. With no voltage on the plates, an extracted beam was observed due to the interaction of the electrons with currents induced in the plates. J.W.Sturgess

16454 STABILIZATION OF THE ACCELERATING POTENTIAL IN A CYCLOTRON.
I.Teodorescu and A.Valeriu.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 2, 361-6 (1959). In Roumanian.

16455 ACCELERATION OF IONS IN A CYCLOTRON WITH AZIMUTHAL VARIATION OF THE MAGNETIC FIELD.
R.A.Mescherov, E.S.Mironov, L.M.Nemenov, S.N.Rybin and Yu.A.Kholmovskii.
Atomnaya Energiya (USSR), Vol. 9, 201 (1960). In Russian. English translation in: Plasma Phys–Accelerators–Thermonuclear Res. (GB), Vol. 3, No. 3, 197-202 (July, 1961).
Experiments are reported on the acceleration of charged particles in the azimuthally varying magnetic field of the 1.5 m cyclotron at the Institute of Atomic Energy, Academy of Sciences, USSR. The creation of a magnetic field of the sector type with about ±15% flutter, for a potential between the dees of about 15 kV, permitted the acceleration of deutrons up to energies of 19 MeV. A study of the motion of the ions in the terminal orbits indicates the possibility of extracting the greater portion of a beam of ions with an energy considerably in excess of 20-22 MeV, by means of an electrostatic deflection system. Relationships are obtained

characterizing the process of acceleration in conditions of an azimuthally varying magnetic field. Experiments are described concerning adjustment of the magnetic field shape by current windings installed inside the accelerator chamber.

16456 NON-SYNCHRONOUS ACCELERATION OF IONS IN CYCLOTRONS. F.M.Russell.
Plasma Phys.-Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 3, 186-96 (July, 1961).

A particular frequency modulation programme is developed with the object of storing ions in the central region of a frequency modulated cyclotron. These ions could subsequently be captured into phase-stable orbits and accelerated in the usual manner, thereby increasing the mean beam intensity obtainable from such a machine. First, a saw-tooth frequency programme is considered in which the rate of frequency change is too fast for ions to be accelerated synchronously. It is shown that there is a bias towards the net acceleration of ions to higher energies. By modifying the shape of the frequency programme it is found that more ions can be extracted from the source than with the simple saw-tooth shape. A frequency programme resembling a blunt saw-tooth is found to give the largest gains. The perturbing effect of successive programmes is examined and an estimate made of the limiting number of ions which can be stored in the centre of a machine.

16457 AUTOMATIC CONTROL OF THE REACTIVE PARAMETERS OF CYCLOTRON RESONANCE SYSTEMS.
A.V.Antonov, Yu.V.Korshunov, E.A.Meleshko and V.S.Panasyuk.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 20-4 (Nov.-Dec.).
In Russian.

Circuits are described which compensate for the change of the natural frequency of the cyclotron resonance system with respect to the oscillator frequency and for the potential redistribution between dees which causes the potential of one dee to rise and the other to fall with respect to earth. These changes are caused by the h.f. heating of the dees by unfocused particles and they take place relatively slowly. This allows mechanical trimmers to be used in both cases. The circuits performed satisfactorily in practice. [English translation in: Instrum. exper. Tech. (USA), No. 6, 879-84 (Nov.-Dec., 1959; publ. Sept., 1960)]. J.W.Sturgess

16458 INJECTION OF VERY HEAVY IONS IN THE 2-METRE ORSAY CYCLOTRON. R.Basile.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 27A-29A (Feb., 1961). In French.

Description of a project for producing highly-charged ions. Atoms of high Z are triply ionized and accelerated to several MeV. They are injected and more thoroughly stripped at the centre of a variable energy and heavy ion cyclotron, which is at present under construction at Orsay.

MAXIMIZING PRODUCTION OF RADIOISOTOPES IN A CYCLOTRON. See Abstr. 13674

16459 COHERENT RADIATION FROM THE ELECTRONS IN A SYNCHROTRON. I.M.Ado and V.V.Elian.
Atomnaya Energiya (USSR), Vol. 9, 455 (1960). In Russian. English translation in: Plasma Phys. Accelerators-Thermonuclear Res. (GB), Vol. 3, No. 3, 213-16 (July, 1961).

The coherent radiation emitted by the electrons in a synchrotron has been studied experimentally at a wavelength of 10 cm for various electron distributions within the phase stable region. This wavelength corresponds to the 50th harmonic of the revolution frequency of the electrons. In the majority of cases these experiments confirm the theory of coherent radiation from electrons but deviations from the theory are observed for electron distributions which approach uniformity. The emitted radiation was used to measure the frequency of the electron phase oscillations and also the adiabatic damping of the phase oscillation amplitudes. These experiments were carried out on the 280 MeV synchrotron at the Physics Institute of the USSR Academy of Sciences, which has betatron start-up.

16460 EVIDENCE OF THE LOSS OF PARTICLES THROUGH SPACE CHARGE, AND OF AN ANOMALOUS MEDIAN PLANE, IN THE SYCHROTRON SATURNE.
G.Gendreau, H.Bruck, A.Gabet, M.Gouttefangeas, J.Hamelin, R.Levy-Mandel, A.Nakach, G.Rastoix, G.Rommel, R.Schoen and R.Vienet.
J. Phys. Radium (France), Vol. 23, No. 2, 93-7 (Feb., 1961).
In French.

Measuremens of the number of particles effectively present in the vacuum chamber at the instant τ_{HF} of acceleration prove that half the particles of the injected beam are lost on the back of the infl due to their interaction. The fundamental effect (repulsion of bunches circulating together) is demonstrated experimentally theoretically. The magnetic median plane, at first 0.5 cm to is lower now that a ferromagnetic radiation shield is put on t the magnet.

DYNAMIC MEASUREMENTS OF LOW MAGNETI FIELDS WITH SPECIAL REFERENCE TO THE STRONG FOCUSING 1.2 GeV ELECTRON SYNCHROTRON AT LUND. See Abstr. 16476

16461 ON THE PROBLEM OF A CYCLOTRON FOR PARTICLES WITH RELATIVISTIC INCREASE IN
L.Krlín.
Czech. J. Phys., Vol. 11, No. 4, 244-52 (1961).

Deals with the problem of circular accelerators with tim constant magnetic field and constant frequency of the accele voltage. An analysis is made of the possibility of compensat the change in time of revolution (caused by the increase in m during energy growth) by simultaneous axial and radial displ ment of the equilibrium orbit. It is found that the problem c solved only with certain approximations. The approximate n cal parameters of the accelerator are given and the approxi tions used are discussed.

16462 THE 157 MeV SYNCHROCYCLOTRON.
C.Bergamaschi, J.C.Brun, A.Cabrespine, R.Gayn J.Génin, H.Langevin-Joliot, N.Marty, A.Michalowicz, P.Radv M.Riou, J.Teillac and C.Victor.
J. Phys. Radium (France), Vol. 21, No. 5, 302-14 (May, 1960) In French.

Low and Mean Energy Nuclear Physics Colloquium, Gre 1960 (see Abstr. 12029 of 1961). The general characteristics synchrocyclotron of the Faculté des Sciences (157 MeV proto its installation are described. The main properties of the ex proton beam (focusing, energy definition, time structure with without additional high modulation frequency at the end of acc tion, intensity measurements with the ionization chamber and Faraday cup) and of the neutron beam (energy spectrum, inte are given. The characteristics of a magnetic analyser of sec particles under construction and a summary of the main uses machine are also given.

16463 METHODS OF IMPROVING THE TIME DISTRIBU OF THE SYNCHROCYCLOTRON EXTERNAL BE
A.Cabrespine.
J. Phys. Radium (France), Vol. 21, No. 5, 332-7 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Gre 1960 (see Abstr. 12029 of 1961). Developed in order to increa efficiency of the particle measurement devices. The pulse r frequency was raised from 450 per second to 40 000 per seco "dead times" were practically eliminated.

16464 PRODUCTION OF PROTON BEAMS OF VARIOU ENERGIES INSIDE THE CHAMBER OF AN INTERMEDIATE-ENERGY SYNCHROCYCLOTRON.
S.S.Vasil'ev, V.V.Komarov, G.V.Koshelyaev and A.M.Popova
Pribory i Tekh. Eksper. (USSR), 1961, No. 1, 17-18 (Jan.-Fe In Russian.

The internal proton beam of a 30 MeV synchrocyclotron allowed to strike a copper target in the form of a 40° wedge. emerging particles, moving in the main magnetic field of the accelerator, were intercepted by a set of nine slits mounted the chamber, and were finally recorded in nuclear emulsions this way nine beams of different energies (in the range 7.5-3 were obtained. S.

16465 DUTY CYCLE IMPROVEMENT ON THE HARVA SYNCHROCYCLOTRON. J.Lefrançois.
Rev. sci. Instrum. (USA), Vol. 32, No. 8, 986-8 (Aug., 1961).

This was obtained by changing the frequency modulation condenser. The protons were ejected over an increased frac the time cycle. It was found that the minimum frequency dri when the new condenser was used and a compensation metho described. Extraction times were increased by greater than factor six. J.W.S

ON A 2 MeV MICROTRON.
6466 É.Kisdi-Koszó and L.Turi.
ohys. Hungar., Vol. 12, No. 4, 273-8 (1960).
2 MeV microtron having 8 orbits is described. Mean
nt intensities of 5 × 10^{-9} A with peaks of 10^{-5} A are
ıable on the last orbits, 50% of which can be brought from the
erator into the laboratory.

MAGNET DESIGN OF A 29 MeV MICROTRON.
467 G.R.Davies, R.E.Jennings, F.Porreca and R.E.Rand.
Cimento Suppl. (Italy), Vol. 17, No. 2, 202-10 (1960).
he design of a magnet for a microtron to accelerate electrons
energy of at least 25 MeV (frequency of r.f. supply 300 Mc/s)
en, as well as details of the power supply to energize the mag-
The precession of the orbits due to non-uniformity of the field
cussed and field measurements, made before and after
ning, are given.

RAPID BEAM EJECTOR FOR THE COSMOTRON.
168 D.C.Rahm.
sci. Instrum. (USA), Vol. 32, No. 10, 1116-19 (Oct., 1961).
The theory and operation of a device that makes the beam in the
otron come onto a target in about 5 μsec instead of the
3 msec are described. The magnetic field in a two-turn
pulsed with a condenser bank, deflects the internal beam
h to throw the beam onto a target during the rise time of the
rbing field. The system has an inductance of 2 μh and a
itance of 11 μf, giving a ringing frequency of 34 kc/s, a
current of 47 000 A at 20 kV and a peak field of 1100 G. The
or can also be used to put only a small fraction of the beam
a target, permitting the rest of the beam to continue on the
al accelerating cycle.

-RAY TUBES AND TECHNIQUES

RESPONSE OF AN X-RAY OPPOSITE-WINDOW
469 MONITOR SYSTEM TO CHANGES IN TUBE
ITIONS. B.W.Delf.
. Instrum. (GB), Vol. 38, No. 9, 359-60 (Sept., 1961).
The variation of the intensity detected by an opposite window
oring system is investigated for large changes in the tube
tions. It is shown that if two normal β filters are inserted in
ffractometer beam, this variation is 0.3% kV^{-1} when the tube
nt is kept constant. If any other number of filters is used the
tion may be as large as 2% kV^{-1} and this variation is explained.
ariation with tube current, when the tube potential is kept
ant, is shown to be 0.3% mA^{-1}.

COUNTING STATISTICS IN X-RAY SPECTROSCOPY.
470 R.C.Stanley.
J. appl. Phys., Vol. 12, No. 9, 503-6 (Sept., 1961).
An investigation was made to see whether the secondary X-ray
ns arrive in a random manner in a commercially available
fluorescence spectrometer, and if so, how the available count-
me might be best used. A sufficiently large number of observa-
was taken to allow a full statistical analysis to be made and
ared with theoretical predictions. In addition, an experimental
igation has been made into the timing accuracy and its effect
final count rate. It was found that for very high counting
above 10 000 counts/sec, or long counting times, above about
utes, small instrumental errors tend to occur, but for count
generally obtained in practice, the X-ray photons are emitted
andom manner and a Poisson distribution is obtained. In
ice one could expect a single observation to be within 0.6% of
ue value for a 256 000 count or 1.3% for a 64 000 count. The
sary statistics for measurements of a given accuracy are set
a form readily usable by the X-ray spectroscopist, together
ormulae and procedure for obtaining the greatest net accuracy
only a limited time is available.

X-RAY EMISSION SPECTROGRAPHY. I. A BENT
471 CRYSTAL SPECTROMETER. A.J.Rose and J.Blandin.
ch. Cent. Nat. Rech Sci. (France), No. 53, 309-12 (Dec., 1960).
nch.
escribes the focusing action of curved crystals in spectrometers
extended sources. A focusing spectrometer is described in
the X-ray take-off angle remains constant at all wavelengths.
The complete spectrograph uses a demountable X-ray tube; the specimen to be analysed is fixed to the anti-cathode and bombarded by a beam of electrons. A.E.I. Research Laboratory

THE EFFECT OF ABSORPTION IN THE β FILTER
16472 ON THE MEAN WAVELENGTH OF X-RAY EMISSION LINES. B.W.Delf.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 305-6 (Aug., 1961).
Measurements were made on the 321 line of W, using CuK_α radiation, with and without β filters. The effect of the filters was to produce a change of wavelength $\Delta\lambda$ (referred to the centroid corrected to 18°C) given by $\Delta\lambda/\lambda = 2.1 \pm 0.4 \times 10^{-5}$, which is in good agreement with the figure of 1.8×10^{-5} given by Wilson (Abstr. 5784 of 1959) on theoretical grounds. J.Thewlis

X-RAY POLARIZER.
16473 H.Cole, F.W.Chambers and C.G.Wood.
J. appl. Phys. (USA), Vol. 32, No. 10, 1942-5 (Oct., 1961).
In the Borrmann effect, or the anomalous transmission, by diffraction, of X-rays through perfect crystals, one state of polarization of the X-ray beam is preferentially absorbed. Since this happens in the "transmitted" as well as in the diffracted beam, a simple polarizer-monochromator is possible in that insertion and rotation of the polarizer does not sensibly change the line of action of the X-ray beam. The "Borrmann crystal" was a single-crystal slab of dislocation-free germanium approximately 3×10^{-2} in. thick and cut for symmetric Laue diffraction from the (220) planes. The details of the rotating crystal holder, an analysis of the polarization, comments on the double-crystal geometrical effects, and an example of the use of the polarizer-monochromator to study the polarization term in Bragg diffraction are presented.

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

MEASUREMENT OF WEAK MAGNETIC FIELDS OF
16474 TERRESTRIAL TYPE. P.Grivet.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 567-620 (1960).
In French.
9th Colloque Ampère Paper (Abstr. 4734 of 1961). Following a brief description of the earth's magnetic field and its variations, a full review is given of the various modern techniques developed both for the relative and absolute measurement of the field. Devices based on nuclear magnetic resonance in liquids are discussed in detail. G.M.Brown

A SIMPLE NUCLEAR MAGNETIC RESONANCE DEVICE
16475 FOR THE MEASUREMENT OF MAGNETIC FIELDS.
G.v.Foerster.
Atomkernenergie (Germany), Vol. 5, No. 6, 230-1 (June, 1960).
In German.
A simple device (on the principle of a Colpitts oscillator) for the precise measurement of static magnetic fields is described. It is used between 4 and 40 Mc/s, corresponding to a magnetic field range of 1000-10 000 Gauss. The device has a high sensitivity over the full range and gives high NMR-signals. Since it is easily operated, it can be used for both laboratory and lecture work. For magnetic field measurement a phase-sensitive detector is added.

DYNAMIC MEASUREMENTS OF LOW MAGNETIC
16476 FIELDS WITH SPECIAL REFERENCE TO THE STRONG FOCUSING 1.2 GeV ELECTRON SYNCHROTRON AT LUND. H.Nysäter.
K. Tekn. Högsk. Handl. (Sweden), No. 174, 30 pp. (1961).
A method employing "peaking strips" has been developed to measure low magnetic fields (up to 2×10^{-2} Wb/m^2) with high accuracy. It was used to obtain the injection time behaviour of the magnetic field of a strong-focusing electron synchrotron.

A NEW ATTEMPT AT VISUAL PRESENTATION OF
16477 MAGNETIC FIELD LINES FOR MEASUREMENT APPLICATIONS. G.Petter.
Naturwissenschaften (Germany), Vol. 48, No. 10, 398-9 (1961).
In German.
A method is described for using an electron beam from a point-

contact cathode to trace out magnetic field lines. The accelerating electric field and the angle between the electron-paths and magnetic field direction are made very small, so that the radius of the helical path traced out is very small, thus giving good definition. The electrons move through a gas at low pressure, giving visible traces which are recorded photographically. R.A.Waldron

16478 DESIGN AND PERFORMANCE OF A FIVE-SECTION NUCLEAR MAGNETIC RESONANCE PROBE FOR ALIGNING PRECISION LABORATORY ELECTROMAGNETS.
S.B.Hillier.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 796-8 (July, 1961).

A special five-section nuclear magnetic resonance probe was developed to facilitate the alignment of precision laboratory electromagnets. A description of the probe and its associated equipment is given along with a discussion of the actual use of the system to obtain detailed information about the magnetic field symmetry of a particular electromagnet. A discussion of accuracies obtainable with the probe is also included.

16479 ON THE THEORY OF FERRO-PROBES WITH LONGITUDINAL SYMMETRICAL SATURATING EXCITATION.
V.I.Drozhzhina, N.N.Zatsepin, Yu.F.Ponomarev, L.A.Fridman, D.A.Shturkin and R.I.Yanus.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 3, 359-66 (Sept., 1960). In Russian.

An analytical study is made of the use of ferro-probes with so-called longitudinal symmetrical saturating excitation for measuring weak, homogeneous or heterogeneous magnetic fields. In formulating the initial equations, the effect of the field due to the eddy currents and of the intrinsic magnetic charge of the core, as well as the possibility of changes taking place in the initial branches of the magnetic polarity reversal loops, are taken into account in greater detail than in other, earlier studies of this subject. The calculations are carried out for the case of no-load conditions of the probe indicator circuit. M.H.Sloboda

16480 THIN FILMS OF INDIUM ANTIMONIDE USED AS MAGNETIC MICROPROBES.
A.Colombani, J.Lavney and J.C.Lecordier.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 237-8 (July 10, 1961). In French.

The construction of small magnetic field measuring probes using the Hall effect in indium antimonide is described. Applications are discussed. S.A.Ahern

16481 EQUIPMENT FOR THE DEPOSITION AND MEASUREMENT OF THE MAGNETIC ANISOTROPY OF THIN FILMS IN A HIGH VACUUM.
V.Kamberský, Z.Málek and J.Kaczér.
Czech. J. Phys., Vol. 11, No. 5, 369-72 (1961).

A description is given of apparatus using the direct torque method for measuring magnetic anisotropy of thin ferromagnetic films in a high vacuum immediately after they have been deposited, without disturbing the vacuum.

16482 ON THE INFLUENCE OF THE IMAGE EFFECT ON THE MEASUREMENT OF MAGNETIC SATURATION BY MEANS OF A MAGNETIC BALANCE AFTER H.LANGE AND K.MATHIEU. R.Kohlhaas and S.Müller.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 222-8. In German.

The design of a magnetic balance is described. The change in the field gradient due to the image effect was investigated for cylinders and spheres having different radii and saturation. The elimination of the image effect allows one to determine the saturation (even as a function of temperature) with an accuracy of 0.1 %. D.S.Parasnis

16483 A NEW METHOD FOR MEASURING ABSOLUTE MAGNETIC SUSCEPTIBILITIES, P.K.Ghosh.
Indian J. Phys., Vol. 35, No. 6, 319-20 (June, 1961).

A brief preliminary discussion.

16484 THE ABSOLUTE MEASUREMENT OF PARAMAGNETIC SUSCEPTIBILITIES AT RADIO FREQUENCIES.
F.Bruin and N.Shahin.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 2, 211-14 (1960).

16485 AN APPARATUS FOR MEASURING MAGNETIC SUSCEPTIBILITY OF GLASSES UP TO THEIR ANNEALING TEMPERATURES. C.R.Bamford and H.Charnc
Phys. Chem. Glasses (GB), Vol. 1, No. 5, 143-7 (Oct., 1960).

The apparatus was designed to study the temperature va of magnetic susceptibility, using a modified Curie method, ov temperature range 20 to 600°C for mass susceptibilities with limits $\pm 2 \times 10^{-6}$ e.m.u./g. Minor modifications could be mad measure higher susceptibility values. The sample volume is approximately 0·5 cm^3. Pole pieces shaped as cylindrical quadrants are used to achieve the "Curie" field configuration force on the sample is measured by a photocell-amplifier me ism applied to the balance arm from which the sample is sus inside a sleeve furnace in vacuo. The susceptibilities of silv aluminium, and fused quartz were measured. The results co favourably with the published values.

16486 POSSIBILITY OF A SPIN WAVE MAGNETIC-MOMENT DETECTOR. T.B.Day and J.Sucher.
J. appl. Phys. (USA), Vol. 32, No. 9, 1788-9 (Sept., 1961).

A theoretical analysis was made of a magnetic moment d depending for its operation on the Cherenkov effect. It is sho there are no theoretical objections to the use of such a syste S.A

16487 USE AND CALIBRATION OF A "GENERAL-RAD ADMITTANCE METER FOR THE MEASUREMEN PERMEABILITY AND PERMITTIVITY. A.Globus.
J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 73A-78A (June, 1961). In French.

The principle of measurements using an admittance met stated. The study of dispersion curves for μ and ϵ demand a high degree of precision in the measurement of admittance, the use of coaxial materials which allow the elimination of th greatest causes of error is described. A complete and impr method of balance and calibration of the admittance meter is which is valid for the entire band of frequencies employed.

16488 AN APPARATUS FOR THE MEASUREMENT OF MAGNETIZATION BETWEEN 2 AND 1200° K.
G.Rimet.
J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 121A-132A (June, 1961). In French.

An apparatus for use in fields up to 30 000 Oe at any tem rure between 2° and 1200° K is described in detail. The magn zation is measured with an accuracy of about 0.5 % by axial extraction out of the gap of a 150 kW electromagnet. The re temperature is obtained in an oven or in a metal-walled Dew vessel, with an accuracy of about 0.5 deg. Samples up to 13 length and from 4 to 8 mm dia., depending on the temperatur can be used.

16489 MAGNETOSTATIC FIELDS AT AN IRON-AIR BOUNDARY. J.Van Bladel.
Amer. J. Phys., Vol. 29, No. 11, 732-6 (Nov., 1961).

It is often stated that the magnetic field in the vicinity of of infinite permeability (hereafter called iron) is perpendicul the boundary surface. This property is not always true. A c is presented which may be used to predict whether the perpe dicularity condition is valid or not. The boundary-value prob for the magnetic field is then formulated for the iron and air

16490 FIELDS IN SQUARE HELMHOLTZ COILS. R.D.Strattan and F.J.Young.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 117-24 (1961).

The axial component of the magnetic field in square Helm coils of rectangular cross-section is investigated. Expressi the axial field are derived and simplified enough so that any specific case can be easily calculated with a small internally programmed digital computer. Plots of the field at the centr the coils as a function of winding thickness with coil spacing parameter are presented. Curves of the variation of the fiel distance from the centre are given. Spherical volumes in wh axial magnetic field varies 1% and 2% are computed for vario configurations. The dimensions of the coils which hold the fi variations to 1% and 2% over the maximum spherical volume given.

491 THE MAGNETIC FIELD IN IRON WITH VARIABLE PERMEABILITY. A.Braunstein.
ners Tekn. Hogsk. Handl. (Sweden), No. 244, 9 pp. (1961).
method of determining two-dimensional magnetic fields is ibed. If hysteresis phenomena are neglected $\mu = A/\sqrt{H^2 + C}$ e used to express the nature of saturation with fair accuracy. ell's equations then yield a non-linear differential equation ibing the magnetic field: this equation is transformed into a partial differential equation of elliptic type by a Legendre formation. [This latter equation is well-known and already d]. M.A.Taylor

492 THE POTENTIAL OF A CIRCULAR CURRENT. G.E.Pringle.
. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 385-92 (April, 1961).
The three-dimensional potential due to a charged circle can be ed in various ways which lead to the same expression in terms toroidal coordinate σ through Legendre functions of s(= cosh σ). ving the same methods to the magnetic potential of a circular ent various results are found:
(a) Legendre's equation yields no solution.
(b) The appropriate transform tion from cylindrical to toroidal dinates gives a Fourier series the coefficients $R_{n-\frac{1}{2}}(s)$ of which, gh not Legendre functions, are related to them by the identity

$$R_m(s) + R_{-m-1}(s) = P_m(s).$$

his method expressions in elliptic integrals are derived.
(c) Direct integration of the solid angle gives an alternative ession in elliptic integrals.

6493 THE STABILITY OF FORCE-FREE MAGNETIC FIELDS. B.B.Chakraborty and P.L.Bhatnagar.
. Nat. Inst. Sci. India A, Vol. 26, No. 6, 592-7 (Nov. 26, 1960).
The condition for a force-free magnetic field to exercise a ilizing influence on an equilibrium configuration is derived with assumptions that the normal component of the field and the ation of the total pressure arising from the disturbance vanish he surface of configuration. For an axisymmetric field and ymmetric disturbance a few cases are pointed out where the e conditions are satisfied.

MAGNET DESIGN OF A 29 MeV MICROTRON.
Abstr. 16467

3494 THE MODIFICATION OF THE PROPERTIES OF A MAGNET BY FRINGE EFFECTS, IN THE CASES OF FORM AND NON-UNIFORM FIELDS.
elbeoch, P.Bounin and G.Proca.
hys. Radium (France), Vol. 21, No. 5, 489-2 (May, 1960).
rench.
Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 0 (see Abstr. 12029 of 1961). It is shown that the fringe field of nstant-gap magnet exerts nearly the same effect as if the net is replaced by a fictitious magnet such that $\int H(z)\,dz$, sured along a line perpendicular to an entrance or an exit face, he same for both magnets. This result may be generalized to pe magnets, but with rather more complicated expressions. Cartan graphical construction may be extended to such nets.

ELECTROMAGNETISM
MAGNETOHYDRODYNAMICS

6495 A STUDY OF A SYMMETRICAL REPRESENTATION OF THE LAWS OF ELECTROMAGNETISM. D.Bayle.
. Acad. Sci. (France), Vol. 252, No. 23, 3535-7 (June 5, 1961).
rench.
A symmetrical tensor representation of the laws of electro-netism subject to special relativity employs the concepts of netic current and electrodynamic potential as a means of ulating field components, to correspond with the concepts of tric current and magnetodynamic potential. Associating erential forms with the various magnitudes in this representation, theory of harmonic forms deduces the existence of harmonic components in the electromagnetic field which unite simultaneously the static and dynamic characteristics of the field, or alternatively, the electric and magnetic characteristics. A.J.McTernan

16496 ON GEOMETRODYNAMICS AND NULL FIELDS. A.Peres.
Ann. Phys. (USA), Vol. 14, No. 1, 419-39 (July, 1961).
The possibility of describing null electromagnetic fields by purely metric concepts has recently been subject to some doubt. Following a method devised by Hlavatý, the relations that a Riemannian manifold must satisfy in order to correspond to a null electromagnetic field are investigated. It is shown that in most cases the fulfilment of five geometrical relations is a necessary and sufficient condition for the existence of a null electromagnetic field. The latter is unique, except for an arbitrary constant phase factor (as in the case of non-null fields). However, in some exceptional cases, there is a larger degree of arbitrariness in the null electromagnetic field that corresponds to a given metric. Such fields (which always possess wave fronts) are not reducible to metric concepts. How it can occur that null electromagnetic fields require the fulfilment of five relations, rather than three, as non-null ones is then examined. In order to settle this question, an attempt is made to consider null fields as a limiting case of non-null ones, by superimposing an arbitrary infinitesimal non-null field on a finite null one. It is then shown that the Rainich vector of such a field does not have a well defined limit, when the perturbing non-null field tends to zero. It is thereby inferred that null electromagnetic fields really have a special status within the frame of geometrodynamics.

16497 A GEOMETRICAL INTERPRETATION OF THE ELECTROMAGNETIC FIELD. E.Figueras.
C.R. Acad. Sci. (France), Vol. 252, No. 23, 3538-40 (June 5, 1961).
In French.
The interpretation is in terms of the "first curvature tensor" $C_{\alpha\beta} = F_{\alpha\lambda}F^{\lambda}{}_{\beta}$, whose algebraic properties are studied. F.A.E.Pirani

16498 A GEOMETRICAL INTERPRETATION OF THE ELECTROMAGNETIC FIELD. E.Figueras.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3745-7 (June 12, 1961).
In French.
Continuation of the preceding abstract. Differential conditions obeyed by the "first curvature tensor" $F_{\alpha\lambda}\,F^{\lambda}{}_{\beta}$ are written down. F.A.E.Pirani

16499 THE MATHEMATICAL THEORY OF THE ELECTROMAGNETIC FIELDS IN ANISOTROPIC INHOMOGENEOUS MEDIA. Y.Hayashi.
Proc. Japan. Acad., Vol. 36, No. 8, 486-91 (Oct., 1960).
Rigorous and general treatment of electromagnetic field equations in general media. In particular, simultaneous integral equations are derived which determine the components of fields in two media separated by a closed surface, the inner medium being anisotropic and inhomogeneous, while the outer is isotropic and homogeneous and the fields satisfy the radiation conditions at infinity. J.K.Skwirzynski

16500 MAXWELL EQUATIONS IN THE FORM OF TWO-COMPONENT EQUATIONS. Vachaspati.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 4, 359-63 (July 26, 1960).
It is shown that Maxwell equations can be written in the same form as the two-component neutrino equation.

16501 CORBINO DISK. M.Green.
J. appl. Phys. (USA), Vol. 32, No. 10, 2047-8 (Oct., 1961).
A discussion of the approximations involved in the mathematical analysis of Corbino disk behaviour (current flow in an applied magnetic field). J.B.Birks

16502 AN OPTICAL ANALOG TO THE MOTION OF MAGNETICALLY TRAPPED PARTICLES. D.Stern.
Amer. J. Phys., Vol. 29, No. 11, 767-71 (Nov., 1961).
It is shown that the motion of a beam of light confined in a diamond-shaped mirror geometry has many properties in common with the motion of magnetically confined particles. The significance and reasons for this are discussed and the long term behaviour of the beam's motion is investigated by a simplified model. In this model it is shown that the solution's behaviour depends on a certain numerical initial condition and fluctuates according to the terms of

its continued fraction development. If this is infinite, the fluctuations will continue indefinitely, on a small though not intrinsically limited scale; however the numerical value is rational and its expansion finite, the fluctuations will exhibit a recurring pattern which may or may not be superimposed on a monotonic drift.

16503 STATIONARY FIELD WITH CYLINDRICAL SYMMETRY IN NON-LINEAR ELECTRODYNAMICS OF BORN AND INFELD. J.Fernández Ferrer and E.De Rafael Gavaldá.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 56, No. 11-12, 273-80 (Nov.-Dec., 1960). In Spanish.

A solution of Born's non-linear electrodynamical equations is given for the stationary case in a cylindrical symmetric field. The results are compared with those given by Maxwell's electrodynamics.

16594 THE EFFECTS OF BETATRON ACCELERATIONS UPON THE INTENSITY AND ENERGY SPECTRUM OF MAGNETICALLY TRAPPED PARTICLES. P.J.Coleman, Jr.
J. geophys. Res. (USA), Vol. 66, No. 5, 1351-62 (May, 1961).

A system composed of relativistic, charged particles in a uniform, slowly varying magnetic field is considered. The initial or unperturbed state of the system is one in which the number of particles per cm^3 with energies greater than E is given by $kE^{-\gamma}$, and in which the particle flux is isotropic. The effects of slow, uniform changes in the field strength upon the integral energy spectrum and upon the omnidirectional intensity of particles with momenta greater than σ are calculated. A simple expression which describes the latter effect is developed. Variations of these two effects are calculated as functions of the parameters, γ and σ.

16505 ON THE BORN—LERTES ROTATIONAL EFFECT. W.F.Pickard.
Nuovo Cimento (Italy), Vol. 21, No. 2, 316-32 (July 16, 1961).

A unified theoretical treatment of the Born—Lertes rotational effect is presented for the special case of a system of two concentric cylinders. It is shown that both the Born and the Lertes effects arise naturally from the concepts of dielectric loss and effective conductivity. A typical theoretical curve is given for the variation of the torque with frequency.

16506 MOTION OF A CHARGED PARTICLE IN AN AXIALLY SYMMETRIC MAGNETOSTATIC FIELD.
E.Mishkin and C.Rader.
Phys. of Fluids (USA), Vol. 4, No. 6, 783 (June, 1961).

The motion of a particle of mass m and charge q in an axially symmetric magnetic field is considered. It is shown that the time derivative of the canonical momentum perpendicular to the axis of symmetry may be derived from a scalar potential. W.E.Williams

16507 THE EFFECT OF NONUNIFORM MAGNETIC FIELDS ON INTERNAL FLOWS OF CONDUCTING FLUIDS.
A.Sherman.
Advances in the Astronautical Sciences, Vol. 6, 817-32, New York: Macmillan (1961).

In this paper the interaction between an inviscid, electrically conducting fluid through a straight two-dimensional channel and a non-uniform magnetic field is quantitatively discussed. Starting with the Maxwell equation, a modified form of Ohm's law and the Navier—Stokes equations corrected to include the Lorentz force and Joule heating, a solution is obtained for the first order approximation on the assumption of the incompressible fluid with constant properties and a zero magnetic Reynolds Number. From numerical results concerning the velocity and temperature throughout the flow field it is deduced that the originally irrotational flow becomes rotational by either viscous or magnetic forces, a loss in total pressure is found, the main flow is relatively unaffected and finally the temperature increases throughout the flow by virtue of the Joule heating corresponding to viscous dissipation.
Mathematical Reviews (S.Ueno)

16508 ON THE COMMENCEMENT OF THE HARTMANN FLOW OF CONDUCTING FLUID.
A.Ogawa and Y.Sone.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1423-6 (July, 1961).

The effect of the transverse magnetic field on the commencement of the two dimensional Poiseuille flow of a conducting fluid between two parallel walls is discussed. Owing to the invariance of the flow characteristics in the direction parallel to the walls, the fundamental equations reduce to linear equations and can be solved exactly. Several limiting cases are surveyed on the ba of the solution obtained. Detailed numerical calculation is als made for a special case in which the values of the Reynolds number, the magnetic Reynolds number and the pressure numb are all equal to unity.

16509 RAYLEIGH'S PROBLEM IN MAGNETOHYDRODYNAMICS FOR A NON-PERFECT CONDUCTOR
D.G.Drake.
Appl. Sci. Res. B (Netherlands), Vol. 8, No. 5-6, 467-77 (1960

The extension of Rayleigh's problem to magnetohydrodynam is considered for a non-perfect conductor in the presence of a transversely applied magnetic field. The governing equations the fluid velocity and the electromagnetic quantities are obtai and the Laplace transform of their solution found. Results ob for the particular cases of a perfect conductor and an insulato are compared. The viscous boundary layer solution and the shearing stress are found, and their dependence on the conduc of the conductor is discussed.

16510 SOME SOLUTIONS FOR STEADY LINEARISED MAGNETOHYDRODYNAMIC FLOWS. W.E.Willia
Appl. sci. Res. A (Netherlands), Vol. 9, No. 6, 424-8 (1960).

It is shown that the solution for the linearized magnetohyd dynamic equations of steady flow may be generated in terms o two independent scalar functions. The two cases of the unpert magnetic and velocity vectors parallel and perpendicular are sidered. The analysis is applied to the case of steady flow pa wavy wall.

16511 SUPERPOSABILITY AND HARMONIC ANALYSIS A VISCOUS LIQUID IN THE PRESENCE OF MAGNETIC FIELDS. P.L.Bhatnagar.
Calcutta Mathematical Society Golden Jubilee Commemoratio Volume (1958-1959) Part I. p. 205-16 [Calcutta Mathematical Society, Calcutta-9, India].

The section on superposability [defined as in the followin abstract]derives some simple sufficient conditions for superpo lity of a pair of solutions of the magnetohydrodynamic equatio The section on harmonic analysis gives the spatial Fourier forms of the magnetohydrodynamic equations. O.P

16512 SUPERPOSABILITY IN MAGNETOHYDRODYNAM G.Teeka Rao.
Proc. Nat. Acad. Sci. India A, Vol. 29, Pt 4, 341-9 (1960).

Two solutions (v_1, H_1) and (v_2, H_2) of the time-dependent magnetohydrodynamic equations are called superposable if $v_1 + v_2$, $H_1 + H_2$ is also a solution. Some simple pairs of supe posable solutions are obtained here. O.P

16513 ON SINGULAR SURFACES IN HYDROMAGNETICS C.N.Kaul.
Appl. sci Res. A (Netherlands), Vol. 9, No. 6, 437-49 (1960).

By applying the compatibility conditions of Thomas (1957) surfaces of discontinuity in continuum mechanics, the singula surfaces of first and second order which may occur in the the hydromagnetics are discussed. It is shown that first order si surfaces are of two types; Alfven waves and contact type of di tinuities. The singular surfaces of second order turn out to b similar to singular surfaces of first order. An expression is obtained for the variation of the ' strength' of the Alfven wave propagates in a fluid at rest under constant pressure and mag field. It is shown that under certain conditions the strength o Alfven wave does not vary as it propagates.

16514 LAMINAR STAGNATION FLOW OF AN ELECTRI CONDUCTING FLUID AGAINST AN INFINITE PL IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD.
A.S.Gupta.
Appl. Sci. Res. B. (Netherlands), Vol. 9, No. 1, 45-50 (1961).

The two-dimensional stagnation flow of an electrically co ing, incompressible and viscous fluid against a plane wall is investigated for the case when the induced field is negligible compared to the imposed transverse magnetic field. It is fou that the component of the velocity parallel to the plate as well the drag coefficient decrease with the increase in the magneti field. Furthermore, it is observed that the velocity componen parallel to the plate is essentially constant except in a layer

it thickness, a result which is true in the non-magnetic case

ELECTROMAGNETIC GENERATION OF VORTICITY
15 IN THE UNIFORM EFFLUX OF A CONDUCTING FLUID
THE SURFACE OF A MAGNETIZED SPHERE. J.D.Murray.
sci. Res. B (Netherlands), Vol. 9, No. 1, 65-76 (1961).
e electromagnetic forces in the flow of an electrically con-
s fluid in the presence of a magnetic field are non-conservative
erefore produce vorticity. The simple case of uniform efflux
nducting fluid from the surface of a magnetized sphere is
i. Two methods are developed: one gives the solution for low
tivity and any magnetic intensity, the other gives the solution
all magnetic intensity and any conductivity. The case
ted in detail is that for a magnetic dipole situated at the
of the sphere. The magnetic lines, streamlines and vortex
re found in closed form and shown for two values of the para-
s involved.

ISENTROPIC ONE-DIMENSIONAL MAGNETO-
516 HYDRODYNAMIC CHANNEL FLOW.
olsky and A.Sherman.
sci. Res. B (Netherlands), Vol. 9, No. 1, 77-84 (1961).
is usual in the analysis of one-dimensional channel flows to
the behaviour of the analgous isentropic flow since, first, it
s the essential features of flows of practical interest and,
dly, it is simpler to describe. Although in conventional
el flows it is sufficient to neglect heat addition and friction to
e isentropicity, in the magnetohydrodynamic (MHD) case it is
ition necessary to neglect Joule heating. This is accomplished
nsidering the fluid as having infinite electrical conductivity.
ver, this procedure does not necessarily imply infinite currents,
the external resistance will limit current flow. In the
ntional problem, if one assumes an isentropic flow, one is
o obtain a once integrated form of the governing equations.
once integrated solutions are not possible in the present
opic MHD channel flow, but equally simple solutions can be
and are presented. Examples of application of these results to
ossed field MHD generator and accelerator are also given.

3517 ON THE STABILITY OF INVISCID PARALLEL FLOW
IN HYDROMAGNETICS. R.K.Jain.
. sci. Res. B (Netherlands), Vol. 9, No. 2, 85-8 (1961).
Discusses the stability of parallel flow of conducting and
cid fluid between two fixed and concentric cylinders in the
ence of an axial uniform magnetic field. It is shown that every
W(r) is stable for infinitesimal perturbations.

THE HALL EFFECT IN THE VISCOUS FLOW OF IONIZED GAS
WEEN PARALLEL PLATES UNDER TRANSVERSE MAGNETIC
D. See Abstr. 15964

INSTABILITY OF VISCOUS, THEMALLY CONDUCTING AND
'ATING MEDIUM. See Abstr. 15606-8

THE GRAVITATIONAL INSTABILITY OF AN INFINITE
IOGENEOUS ROTATING VISCOUS MEDIUM IN THE
SENCE OF A MAGNETIC FIELD. See Abstr. 15609

MAGNETOGRAVITATIONAL INSTABILITY OF AN INFINITE
IUM WITH FINITE ELECTRICAL AND THERMAL
DUCTIVITY. See Abstr. 15610

ON THEOREMS OF MINIMUM ENERGY DISSIPATION
3518 IN MAGNETOHYDRODYNAMICS. L.N.Tao.
.. sci. Res. B (Netherlands), Vol. 9, No. 2, 161-8 (1961).
This paper is concerned with some theorems on the dissipation
nergy in magnetohydrodynamics. It is shown that when certain
litions are satisfied, the steady motion of an electrically
ducting imcompressible fluid has an absolute minimum of energy
ipation. Furthermore, when the same conditions are satisfied,
nsteady motion with steady boundary conditions always tends to
steady state, which is stable as well as unique. The present
rems are also applicable to ordinary hydrodynamics and
netohydrostatics. An implication of these theorems is dis-

HYDROMAGNETIC TURBULENCE.
3519 S.Nagarajan.
ophys. J. (USA), Vol. 134, No. 2, 447-55 (Sept., 1961).
A rederivation of Chandrasekhar's elementary theory of hydromagnetic turbulence (Chandrasekhar, 1955) is given, which makes clear the physical implications of his extension of Heisenberg's ideas to hydromagnetics. The cascade equations are reduced to two equivalent differential equations for the case of finite viscosity and resistivity. A perturbation procedure is employed to prove that one of Chandrasekhar's solutions (the velocity mode) becomes unacceptable for the case of finite viscosity and resistivity. The implications of this result are discussed critically and compared with other theories.

ON TRANSITION RÉGIMES IN CERTAIN FLOWS OF A
16520 PERFECTLY CONDUCTING FLUID. R.Peyret.
C.R. Acad. Sci. (France), Vol. 252, No. 19, 2816-18 (May 8, 1961).
In French.

Steady two-dimensional isentropic flow of an inviscid perfectly conducting compressible fluid is treated. The magnetic and velocity fields are taken to be parallel everywhere and to become uniform at infinity. Linearized equations for the perturbations from the flow at infinity are quoted. Four cases are considered, with the Mach number M, or the Alfvén number $A \equiv \sqrt{\mu\rho}\,V/B$, or $A^2 + M^2$, or both A and M, assumed close to 1 at infinity. O.Penrose

SURFACES OF DISCONTINUITY WITH EMISSION OR
16521 ABSORPTION OF ENERGY IN MAGNETOHYDRO-
DYNAMICS. A.A.Barmin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 77-80 (May 1, 1961).
In Russian.

Classification of the various possible solutions of the shock conditions for oblique magnetohydrodynamic shocks in which chemical reactions take place. For exothermic reactions there are six types, roughly because each of the three nonmagnetic types (deflagrations and strong and weak detonations) splits into two corresponding to the fast and slow shocks possible when there is no chemical reaction. For endothermic reactions there are likewise six types. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 374-6 (Oct., 1961)]. O.Penrose

A NON-STEADY PROBLEM OF MAGNETO-
16522 HYDRODYNAMICS. D.V.Sharikadze.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 3, 568-71 (May 21, 1961).
In Russian.

For abstract, see Abstr. 13161 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 387-90 (Oct., 1961)].

MOTION OF A MEDIUM WITH FINITE CONDUCTIVITY
16523 IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD.
D.V.Sharikadze.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 4, 817-19 (June 1, 1961).
In Russian.

Obtains exact solutions of the magnetohydrodynamic problems for the motions of compressible and for viscous, incompressible media in uniform magnetic fields. Both stationary and non-stationary motions are considered. The solutions are formulated in terms of integral equations which can be solved by successive approximations. [English translation in: Soviet Physics—Doklady (USA)]. J.K.Skwirzynski

THERMODYNAMIC PROPERTIES OF FLUID FLOW
16524 ACROSS A MAGNETIC FIELD.
I.J.Singh and K.P.Chopra.
Indian J. Phys., Vol. 35, No. 6, 271-7 (June, 1961).

Deals with the study of the various thermodynamic quantities like internal energy, enthalpy, entropy, etc., involved in the investigation of the flow of a conducting fluid in the presence of a uniform transverse magnetic field. The analogues of Rayleigh and Fanno lines readily follow from the basic equations. It is shown that the internal energy and enthalpy of an electrically conducting fluid obeying perfect gas laws depends, in the presence of a transverse magnetic field, on its density and the strength of the magnetic field. The entropy and the specific heat at constant volume do not seem to be affected by the presence pf the magnetic field. The behaviour of the specific heat at constant pressure depends on whether the gas pressure or the total pressure is kept constant. A transverse magnetic field reduces the specific heat at constant gas pressure and the corresponding adiabatic constant by a factor proportional to the ratio of the magnetic pressure to the gas pressure. However, if the total pressure is kept constant, the magnetic field has no effect on the specific heat. Lastly, the effect of the magnetic field on the velocity of sound is discussed. In the limiting cases of weak and

strong magnetic fields, the velocity of sound reduces to the ordinary sonic speed and the Alfvén speed respectively.

16525 HYDROMAGNETIC OSEEN FLOW PAST AN ELLIPTIC CYLINDER IN A UNIFORM MAGNETIC FIELD. T.Miyagi.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1434-46 (July, 1961).

Deals with the flow of a viscous, incompressible and electrically conducting fluid past an inclined elliptic cylinder in a parallel magnetic field, making use of a perturbation method similar to the Oseen approximation. Approximate formulae for the forces experienced by the cylinder are obtained only to the lowest order of the Reynolds number and the magnetic Reynolds number. The drag and lift coefficients are then expressed as functions of five non-dimensional parameters, i.e., the Reynolds number, the magnetic Reynolds number, the pressure number, the thickness-ratio and the angle of incidence of the cylinder. Numerical calculations for the drag and lift coefficients as well as their ratio are carried out for various values of these five parameters. It may be noted in the numerical results that the angle of incidence of the cylinder at which the lift coefficient has a maximum value increases with the increase of the pressure number S when $S < 1$, and the reverse is the case when $S > 1$.

16526 THE EFFECT OF A TRANSVERSE MAGNETIC FIELD ON INTERNAL STRUCTURE AND HYDRAULIC RESISTANCE IN TURBULENT FLOW OF LIQUID METAL. H.Branover and O.Lielausis.
Latv. PSR Zinat. Akad. Vestis (USSR), No. 1, (162) 59-66 (1961). In Russian.

In one experiment the hydraulic resistance and the velocity profile for flow in a smooth-walled tube are measured; when both the Reynolds and the Hartmann numbers are large the velocity becomes almost uniform. For a rough-walled tube the results are similar but the velocity near the walls is always appreciably slower. Another experiment shows that the dissolution of lead in flowing mercury is slowed down by the magnetic field. O.Penrose

16527 THE STABILITY OF VISCOUS FLOW BETWEEN ROTATING CYLINDERS IN THE PRESENCE OF A MAGNETIC FIELD. II. S.Chandrasekhar and D.D.Elbert.
Proc. Roy. Soc. A (GB), Vol. 262, 443-54 (Aug. 8, 1961).

The theory developed in Pt I (Abstr. 3905 of 1953) is extended to allow for counter-rotation of the two cylinders. Explicit results are given for the case when the two cylinders rotate in opposite directions with equal angular velocities.

16528 TORQUE ON A CIRCULAR DISC ROTATING IN A LIQUID UNDER THE INFLUENCE OF A UNIFORM MAGNETIC FIELD PERPENDICULAR TO THE DISC. M.Ray.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 320-5 (May 26, 1960).

The influence of a uniform magnetic field on the couple resisting the rotation of a circular disk in an electrically conducting liquid is examined, the field being applied perpendicular to the disk. Basic equations of hydrodynamics, suitably modified, together with Maxwell's equations, are solved to suit the boundary conditions by constructing integral solutions. It is found that, when the field is weak, the field helps the rotation on one side and retards it on the other.

16529 ON THE STABILITY OF A GRAVITATING CYLINDER IN THE PRESENCE OF A MAGNETIC FIELD. F.C.Auluck and N.K.Nayyar.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 469-77 (Sept. 26, 1960).

The stability of a gravitating cylinder of infinitely conducting fluid is studied in the presence of poloidal magnetic fields which have a sinusoidal variation of type $\cos m\pi r^2/2R_0^2$ where m is an odd integer and of type $\sin n\pi r^2/2R_0^2$ where n is an even integer, so that the magnetic field vanishes at the boundary. It is shown that the field increases the stability of the cylinder and for large values of m and n the stabilizing effect of this field is the same as that of a uniform longitudinal magnetic field studied by Chandrasekhar and Fermi (Abstr. 33 of 1954).

16530 ON THE STABILITY OF A SOLUTION IN HYDROMAGNETICS IN THE PRESENCE OF DISSIPATIVE FORCES. J.N.Kapur and R.K.Jain.
Z. Astrophys. (Germany), Vol. 52, No. 2, 110-17 (1961).

In the present paper, the stability of the solution

$$u = \frac{H}{\sqrt{4\pi\rho}}\left(0, \frac{r}{p}, 1\right)$$

of the equations of hydromagnetics in the presence of dissipa forces has been discussed. It has also been shown that Rose and Longmire's criterion for stability is, in general, not appl to a dynamical equilibrium.

16531 ON MAGNETOHYDRODYNAMIC SHOCK WAVES. R.P.Kanwal.
J. Math. Mech., Vol. 9, 681-95 (1960).

For a non-dissipative unsteady plane magnetohydrodynam flow, the jumps in various flow quantities across a curved sh calculated in terms of the (assumed constant) upstream state the local shock curvature and velocity. The magnetic field is normal to the plane of flow. The author employs the general magnetohydrodynamic shock conditions of Friedrichs which h derives, using methods developed for gas dynamics by Thoma (1949). Mathematical Review (H.C.K

16532 PLANE WAVE MOVEMENT OF AN INCOMPRESS CONDUCTING LIQUID WITH ELECTROMAGNET RADIATION TAKEN INTO ACCOUNT. A.E.Yakubenko.
Dokl. Akad. Nauk. SSSR, Vol. 136, No. 6, 1310-12 (Feb. 21, 19
In Russian.

A steady electric current flows through a liquid layer an liquid is set in motion in a direction perpendicular to the cur It is assumed that the two halves of the liquid move in opposi direction. Oscillatory movement results; its progress and th accompanying fluctuations of the electromagnetic field are in gated theoretically. [English translation in: Soviet Physics - Doklady (USA), Vol. 6, No. 2, 125-7 (Aug., 1961)]. R.Eise

16533 AXIALLY SYMMETRIC MAGNETOHYDRODYNAM OSCILLATIONS IN AN ELECTRICALLY CONDUC ISOTHERMAL ATMOSPHERE SUBJECT TO GRAVITATION. T.Zeuli.
Atti Accad. Sci. Torino (Italy), Vol. 95, No. 4a, 460-72 (1960-6
In Italian.

The equation for oscillations, symmetric about a vertica axis, in a horizontally stratified atmosphere, are reduced to single ordinary differential equation for the special cases (1) azimuthal velocity or magnetic field (2) no radial velocity. O.P

16534 NOTE ON HYDROMAGNETIC WAVES IN A COMPRESSIBLE FLUID CONDUCTOR. J.Carst
Proc. Nat. Acad. Sci. USA, Vol. 47, No. 6, 891-9 (June, 196

It is known that an effect of introducing compressibility linearized equations of hydrodynamics is to introduce a discr tion between the longitudinal and transverse components of v and current density, in that only the longitudinal components propagated with the Alfven velocity, the transverse componen being coupled to the density fluctuations or "convected with t fluid". The author finds a somewhat similar behaviour for th expansion tensor and for a tensor derived from the magnetic The transverse components of these tensors all satisfy the s sixth-order differential equation and a preliminary discussio resulting dispersion relations is given. H.N.V.Te

16535 GREEN'S FUNCTION FOR TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC WAVES. I. H.Weit
Phys. of Fluids (USA), Vol. 4, No. 10, 1238-45 (Oct., 1961).

The Green's function is evaluated for the Lundquist equa linearized about zero flow velocity and constant matter densi and magnetic field. It is also assumed that all quantities dep on two space variables and time only and that the constant m field lies in the plane of the chosen two space variables.

16536 GREEN'S FUNCTION FOR TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC WAVES. II. H.Wei
Phys. of Fluids (USA), Vol. 4, No. 10, 1246-50 (Oct., 1961).

As an extension of Pt I the Green's function is evaluated the Lundquist equation linearized about uniform magnetic fie constant matter density, and zero flow velocity. It is assum all quantities are functions of two space variables and time o In the general magnetic field configuration considered here a Alfvén disturbance no longer exists; there is instead a wave properties of both the Alfvén and fast-slow disturbance.

16537 MAGNETOHYDRODYNAMIC WAVES IN CYLINDRICAL WAVEGUIDES AND TOROIDAL RESONATORS.
abó and I.Abonyi.
hys. (Germany), Vol. 163, No. 5, 535-8 (1961). In German.
The properties of small amplitude magnetohydrodynamic waves aveguides with rectangular and circular cross-sections are stigated. The same principles are applied in a discussion of ionary waves in a toroidal resonator. It is found that in both s longitudinal, transverse and composite waves are possible.
C.D.Lustig

16538 THE STEADY STATE OF THE CHAPMAN—FERRARO PROBLEM IN TWO DIMENSIONS. J.W.Dungey.
eophys. Res. (USA), Vol. 66, No. 4, 1043-7 (April, 1961).
The steady state of the Chapman—Ferraro problem is nulated in mathematical terms, but the three-dimensional blem presents little hope of an analytical solution, and it is not n obvious how to compute the solution. The two-dimensional blem is reduced to a standard potential problem and solved ctly. The solution is used to obtain an indication of the error he flat-faced approximate model that has been used previously hree dimensions.

16539 ON THE REFLECTION AND REFRACTION OF HYDROMAGNETIC WAVES IN IONISED GAS.
lamikawa.
eomagn. Geoelect. (Japan), Vol. 12, No. 3, 117-28 (1961).
The manner of propagation of hydromagnetic waves in the th's upper atmosphere, is discussed. Although the density nges continuously in the atmosphere and the steady magnetic d is a dipole field, the laws of reflection and refraction of hydro- gnetic waves at a plane boundary between two semi-infinite nogeneous media of anisotropic electrical conductivity under a form steady magnetic field are sought. When the steady magnetic d is perpendicular to the boundary plane, the laws of reflection refraction are simple, but when the steady magnetic field makes angle with the plane, they are complicated. The incident linary (or extraordinary) waves may be reflected or refracted as ordinary or extraordinary waves and propagate anisotropically.

16540 CORRECTION TO THE PAPER "TWO-DIMENSIONAL FLOW OF AN IDEAL GAS WITH SMALL ELECTRIC NDUCTIVITY PAST A THIN PROFILE". T.Sakurai.
Phys. Soc. Japan, Vol. 15, No. 6, 1135-6 (June, 1960).
The author re-examined the results of the previous investiga- n (Abstr. 7134 of 1961) and found that the forward wake in the sonic case would appear in the direction

$$\theta = \pi + \frac{2}{\sqrt{1-M_0^2}}\delta,$$

tead of the presviou result

$$\theta = \pi + \frac{2}{\sqrt{1-M_0^2}}\{1 \pm M_0\sqrt{1-M_0^2}\}\delta$$

rther it is found that the results in the supersonic case have an ra factor $1/\sqrt{2}$, in the limit of ordinary gas dynamical case
S.P.Talwar

16541 COUETTE FLOW OF A FULLY IONIZED GAS, CONSIDERED AS A TWO-COMPONENT FLUID.
A.Peletier and L.Van Wijngaarden.
pl. sci. Res. B (Netherlands), Vol. 9, No. 2, 141-50 (1961).
The equations, governing the behaviour of a fully ionized gas, given by Spitzer, are applied to two types of magnetohydro- namic Couette flow. The features of the flow are expressed in rms of the Hartmann number and a parameter q, being the ratio tween Larmor frequency and collision frequency. Compared with results of the one-component theory an additional velocity mponent is found.

16542 SOME CONSIDERATIONS ON THE FUNDAMENTAL EQUATIONS OF ELECTRO-MAGNETO-GASDYNAMICS.
.Pai.
lcutta Mathematical Society Golden Jubilee Commemoration lume (1958-1959) Part I. p. 235-48 [Calcutta Mathematical iety, Calcutta-9, India].
The fundamental equations of the flow problems of electrically conducting fluids, particularly of ionized gases (plasma), are discussed and the magnetogasdynamics approximations are derived. The general properties of fundamental equations of magnetogasdynamics are discussed. The most important parameters of magnetogasdynamics: the magnetic pressure number and the magnetic Reynolds number are defined. Their influence on the flow field is considered. The magnetogasdynamics approximations are then reexamined. The generalizations of the analysis of magnetogasdynamics to electromagnetogasdynamics, radiation-magnetogasdynamics and magnetogasdynamics in a gravitational field are briefly treated. Finally the one-dimensional flow problems of magnetogasdynamics are treated in some detail which includes the characteristics of one-dimensional unsteady flow and the steady flow through a nozzle.

16543 SHOCK WAVES IN RADIATION-MAGNETO-GAS DYNAMICS. S.I.Pai and A.I.Speth.
Phys. of Fluids (USA), Vol. 4, No. 10, 1232-7 (Oct., 1961).
The general Rankine—Hugoniot relations for a normal shock wave in radiation-magneto-gas dynamics are investigated. These relations differ considerably from those without radiation effects, particularly for the case that the gas is initially so hot that the radiation pressure is not negligible. For a given strength of the shock wave, the temperature jump across the shock with radiation effect is much smaller than that without radiation effect. Various limiting cases are discussed. In certain cases, the results may be expressed in terms of an effective ratio of specific heats and an effective gas pressure. A general method of solution by successive approximations is given and some numerical results are obtained.

16544 TRANSONIC FLOW IN A MAGNETOHYDRODYNAMIC GENERATOR. D.T.Swift-Hook.
Phys. of Fluids (USA), Vol. 4, No. 10, 1316-17 (Oct., 1961).
The author shows that it is theoretically possible to have a smooth transonic deceleration in a magnetohydrodynamic generator with a divergent duct. The question of the stability of the resulting transonic flow is not investigated. W.E.Williams

HYDROMAGNETIC WAVES AND THE TRAPPED RADIATION OF THE VAN ALLEN BELT. See Abstr. 15336-7

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

16545 ON THE RECEPTION OF ELECTROMAGNETIC WAVES. H.Bondi.
Proc. Roy. Soc. A (GB), Vol. 261, 1-9 (April 11, 1961).
The energy that can be obtained from an electromagnetic wave by a localized receiver is considered for the non-harmonic case. If the currents in the receiver are chosen so as to maximize the amount of energy obtained, with conditions implying that the reeeiver is quiescent outside a finite interval of reception, then there exists a well-defined maximum. For a limited interval of transmission, this maximum depends closely on the length of the interval of reception. If the restriction on the receiving current is relaxed, then there exist circumstances in which the wave theory considerations must be supplemented by allowing for induction effects.

COHERENCE PROPERTIES OF ELECTROMAGNETIC RADIATION. See Abstr. 16048

16546 THEORY OF MULTIPOLE RADIATION. S.C.Snowdon.
J. math. Phys. (USA), Vol. 2, No. 5, 719-22 (Sept.-Oct., 1961).
The decomposition of the electromagnetic field into longitudinal, transverse electric, and transverse magnetic field types is examined in relation to a similar decomposition of the sources. In general, three independent scalar aspects of the current and charge densities must be specified to provide longitudinal and transverse electromagnetic fields. If, in addition, it is required that the sources be continuous and spatially localized functions, only two independent scalar aspects of the sources are needed to provide the electromagnetic fields outside the sources.

16547 AN ELEMENTARY DERIVATION OF THE FORMULAE FOR MULTIPOLE RADIATION. B.Średniawa.
Acta phys. Polon. (Poland), Vol. 19, No. 4, 477-85 (1960).

Expressions for the field intensities of various electromagnetic multipole radiations produced by electric charges and currents as well as by electric and magnetic polarizations varying harmonically in time are deduced by developing the retarded potentials into series. The formulae obtained are direct generalizations of the Rubinowicz–Sommerfeld formulae for dipole and quadrupole radiations and are valid in the wave zone. The general formulae for the field intensities are also given in tensor form.

16548 TRANSIENT PHENOMENA ASSOCIATED WITH SOMMERFELD'S HORIZONTAL DIPOLE PROBLEM. H.J.Frankena.
Appl. sci. Res. B (Netherlands), Vol. 8, No. 4, 357-68 (1960).

A horizontal electric dipole, located above the plane interface of two non-conducting media, has a dipole moment which is an arbitrary but given function of time when $t > 0$ and which is zero when $t < 0$. Travelling electromagnetic waves, generated by this dipole, are calculated with the aid of a modification of Cagniard's method. For the electric field vector above and at the interface expressions are obtained for the direct and reflected waves in the case that the velocity of light in the medium containing the source is the larger one.

16549 RADIATION OF PULSES GENERATED BY A VERTICAL ELECTRIC DIPOLE ABOVE A PLANE, NON-CONDUCTING, EARTH. A.T.de Hoop and H.J.Frankena.
Appl. sci. Res. B (Netherlands), Vol. 8, No. 4, 369-77 (1960).

At a height h above a plane, non-conducting earth, a vertical electric dipole emits an impulsive electromagnetic wave. The resulting electromagnetic field in the air is determined; it consists of a reflected wave which is superimposed upon the given incident wave. The Hertzian vector corresponding to the reflected wave is expressed in terms of a single integral over a finite interval; this integral is written in such a form that its numerical evaluation can easily be performed.

16550 THE ELECTROMAGNETIC FIELDS OF A DIPOLE IN THE PRESENCE OF A THIN PLASMA SHEET. J.R.Wait.
Appl. sci. Res. B (Netherlands), Vol. 8, No. 5-6, 397-417 (1960).

The problem of electric and magnetic dipoles located near a thin planar slab or sheet of ionized material is considered. A constant and uniform magnetic field is impressed on the slab. Under the assumption that the thickness of the slab is very small, expressions for the resultant fields are obtained. As a result of the anisotropy of the sheet the fields are elliptically polarized in general. On carrying out a saddle-point evaluation of the integrals in the formal solution, it is shown that the far fields may be split into "radiation" and "surface-wave" components. The dependence of the radiation pattern and the surface-wave characteristics on electron density, collision frequency and the impressed magnetic field is illustrated.

EXCITATION OF ELECTROMAGNETIC WAVES IN A MAGNETO-ACTIVE PLASMA BY A BEAM OF CHARGED PARTICLES.
See Abstr. 16325

SCINTILLATION EFFECT IN VALVE SELF-OSCILLATORS.
See Abstr. 16394

16551 THERMODYNAMICS AND STATISTICAL MECHANICS OF A THREE-LEVEL MASER. W.A.Barker.
Phys. Rev. (USA), Vol. 124, No. 1, 124-8 (Oct. 1, 1961).

The three "spin" states of a maser are treated as individual chemical species. It is assumed that these three species are in thermal equilibrium with the lattice at temperature T but that they are not necessarily in chemical equilibrium with one another. The principle of minimun entropy production is used to derive an equation of reaction equilibrium from which the steady-state behaviour of the system with a microwave pump may be completely described. In addition to the population distribution, which is in agreement in first order with the results obtained by solving the rate equations, explicit expressions are obtained for the internal energy, heat capacity, and entropy. The calculations are extended to include spontaneous emission and cross-relaxation as well as the usual thermal relaxation mechanisms.

16552 FIELD-SWEPT MASER OSCILLATION. J.C.Kemp.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 21-3 (July 1, 1961).

Kemp's measurements have been cited by Singer and Wang (Abstr. 8388 of 1960), as experimental verification of their analysis. It is shown that in these experiments the maser oscil ation envelope had a structure almost entirely dependent on fiel sweep. An analysis starting from the coupling equation betwee radiation field and transverse magnetisation agrees well with t results. Thus the general model of Singer and Wang is not rele D.W

16553 THE EFFECT OF FLOW IN A NUCLEAR RESONAN MASER AT HIGH FIELD STRENGTHS. C.Fric.
Ann. Phys. (France), Vol. 5, No. 11-12, 1501-57 (Nov.-Dec., 19 In French.

A complete study was made of the properties of a nuclear resonance maser operating at high field strengths and using a flowing liquid. S.A.A

16554 DESIGN AND OPERATION OF A MOLECULAR OSCILLATOR. H.G.Venkates and M.W.P.Strandber
Proc. Indian Acad. Sci. A, Vol. 51, No. 3, 123-36 (March, 1960).

Theoretical implications of the design of a two-level maser the molecular-beam type are presented. The design and operat of a microwave maser that employs a beam of ammonia molecu are described.

16555 MEASUREMENT OF THE GROUP VELOCITY IN T RETARDING SYSTEM OF A MASER. V.B.Shteinshleiger and G.S.Misezhnikov.
Pribory i Tekh. Eksper. (USSR), 1959, No. 6, 133 (Nov.-Dec.). In Russian.

A method is proposed for direct measurement of the group velocity v_g (dispersion curves are not used), which is the speed with which the envelope of a modulated wave moves. The phase shift caused in a sinusoidal envelope by a retarding system of l length is measured, and from this v_g is deduced. [English tran tion in: Instrum. exper. Tech. (USA), No. 6, 989 (Nov.-Dec., 19 publ. Sept., 1960)]. J.M.B

16556 POWER OUTPUT CHARACTERISTICS OF A RUBY LASER. M.L.Stitch.
J. appl. Phys. (USA), Vol. 32, No. 10, 1994-9 (Oct., 1961).

The theoretical power output of a ruby laser is examined u certain idealized operating conditions, and it is found that there two principal regions of operation. These are the regions of st oscillation characterized by the condition $p\tau_2/A > h\nu_{13}/\sigma_{13}$. Her p/A is the "pumping" illumination within the absorption band of ruby, τ_2 is a characteristic relaxation time of fluorescence in r τ_3 is a characteristic thermal relaxation time from the excited U band, ν_{13} is the pumping frequency, and σ_{13} is the interaction cross-section between pumping radiation and Cr^{3+} ions in ruby. The efficiency of operation is examined under two limiting cond

16557 SUBSTITUTION METHOD OF MEASURING STANDI WAVE RATIO. W.M.Nunn, Jr.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1106-10 (Oct., 1961).

A general set of standing wave relations, applicable to the and i.f.-substitution techniques, are derived and used in the subsequent development of curves appropriate to measurement made around the pattern minimum. Although the experimental results using the r.f. substitution procedure were not recorded a v.s.w.r. in excess of 200 : 1, there appears to be no limit on magnitude of standing wave ratio that can be measured, if suita equipment is available. An analysis of errors reveals that the principal factor which influences the accuracy attainable is the precision with which the attenuator can be determined.

16558 ON THE THEORY OF THE OPEN RESONATOR. P.Szulkin.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 11- 639-45 (1960).

The resonator considered consists of two circular perfectl conducting disks of equal radius, placed with their planes paral and their axes coincident. Expressions for the electromagnetic fields are given, and an equation is derived for the approximate resonance frequencies of the system. R.A.Wa

16559 IMPEDANCE BOUNDARY CONDITIONS FOR IMPERFECTLY CONDUCTING SURFACES.
T .A.Senior.
A l. Sci. Res. B (Netherlands), Vol. 8, No. 5-6, 418-36 (1960).
It is shown how the exact electromagnetic boundary conditions a ie surface of a material of large refractive index can be approxi- r ed to yield the usual impedance or Leontovich boundary con- c ons. These conditions relate the tangential components of the e tric and magnetic fields (or the normal components and their r mal derivatives) via a surface impedance which is a function c of the electromagnetic properties of the material. They are v d for surfaces whose radii of curvature are large compared v i the penetration depth, and also for materials which are not l iogeneous but whose properties vary slowly from point to point. A the refractive index (or conductivity) increases to infinity, the c ditions go over uniformly to the conditions for perfect conduct- i y.

16560 IMPEDANCE BOUNDARY CONDITIONS FOR STATISTICALLY ROUGH SURFACES. T.B.A.Senior.
. ol. Sci. Res. B (Netherlands), Vol. 8, No. 5-6, 437-62 (1960).
It is shown that for an electromagnetic field incident on a fectly conducting surface having small geometrical irregularities ich are distributed at random but in a statistically uniform and tropic manner, the boundary condition can be replaced by a neralized impedance condition applied at a neighbouring mean face. The surface impedance is a tensor function of the direction which the field is incident as well as of the statistical properties the irregularities, but simplifies in certain particular cases. hough the detailed analysis is carried out for a mean surface ich is flat, the boundary condition is applicable to a curved face providing the radii of curvature are large in comparison h the wavelength. It is believed that this approach is of value studying the effect of minor surface roughnesses on the scattering electromagnetic waves.

ELECTROMAGNETIC AND SPACE CHARGE WAVES IN A EATH HELIX. See Abstr. 16403

PROPAGATION OF E.M. WAVES IN A PLASMA IN MAGNETIC LD. See Abstr. 16313

16561 REFLECTION OF PLANE WAVES BY RANDOM CYLINDRICAL SURFACES. L.G.MacCracken.
Roy. Soc. New S. Wales (Australia), Vol. 95, Pt 1, 43-6 (1961).
For an aperiodic cylindrical metallic surface illuminated by rizontally polarized radiation, the reflected field is established a superposition integral and the reflection function obtained as integral representation, whose integrand contains surface pendent functions. Proceeding to the optics limit, the reflection action is found proportional to the Fourier transform of $\exp[Qz]$, ere Q depends on grazing angle and wavelength and z is the rface height. Allowing a stationary stochastic process for the rface, the reflection coefficient, on the average, agrees with all eviously derived results and the received intensity shows a pendence on the auto-correlation, $\rho(\eta)$, of the surface.

REFLECTION OF ELECTROMAGNETIC WAVES AT ELECTRON NSITY RAMPS. See Abstr. 16331

16562 THE REFLECTION OF RADIO WAVES FROM AN ICESHELF. W.R.Piggott and L.W.Barclay.
atmos. terrest. Phys. (GB), Vol. 20, No. 4, 298-9 (April, 1961).
Vertical-incidence ionospheric measurements made by the oyal Society Expedition to Halley Bay, Antarctica, are used to tain information about the r.f. properties of the iceshelf on which e Base is situated. From measurements at 2.2 Mc/s and at 0 Mc/s of the total loss due to reflection from the F-layer and from e ground, the ground loss was found to be approximately 2 dB, rresponding to a reflection coefficient of about 0.8. Such a value plies that the dielectric constant of the reflecting surface is near 0. Since the dielectric constant for a snow or ice sheet lies tween 1 and 3, it is concluded that the reflection actually occurs the interface between the sea and the iceshelf and not the inter- ce between the iceshelf and the air, as the sea is an almost rfect reflector at the frequencies used. The power radiated ward shows variations with frequency whose periodicity is termined by the virtual depth, at radio frequency, of the reflecting rface. Minima in the radiated power were found at the same radio equencies on different occasions, the mean frequency interval corresponding to a period of 0.6 Mc/s. Allowing for the probable values of the dielectric constant at different depths in the iceshelf, the depth of the reflecting interface is thus found to be close to 150 m, which is in good agreement with the depth of 143 ± 20 m found by MacDowall on the assumption that the iceshelf is in hydrostatic equilibrium. A.Wilkinson

16563 ON THE INTERFERENCE OF PULSE SIGNALS WITH REFLEXION FROM A PLANE. P.Szulkin.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 11-12, 629-37 (1960).
A transmitting and a receiving aerial are considered, above a ground plane, and the effects are discussed of interference between a direct signal and one reaching the receiver after reflection from the ground. The direct and reflected pulses are separated when the height of the receiving aerial is greater than a certain value depending on pulse length, height of the transmitter above the ground, and the distance apart of the aerials. Below that height there are varying degrees of overlap. The significance of these effects for radiolocation and ship-to-aeroplane, aeroplane-to-aeroplane, and ground-to-aeroplane microwave communications is discussed. R.A.Waldron

16564 DIFFRACTION OF ELECTROMAGNETIC WAVES BY SOUND WAVES. H.J.Schmitt.
J. Acoust. Soc. Amer., Vol. 33, No. 10, 1288-92 (Oct., 1961).
For the diffraction of electromagnetic waves from a standing sound wave the amplitudes of the first diffraction order are calculated from Born's approximation. If the wavelength of the electromagnetic signal is made comparable to the acoustic wavelength, the first diffraction order vanishes periodically with increasing width of the sound beam because of a destructive interference of scattered waves. The sound-perturbed medium becomes also slightly anisotropic. The diffraction of microwaves by a standing sound wave in oil is measured as a function of sound frequency and polarization of the electromagnetic wave.

16565 APPROXIMATE FORMULAE FOR THE DIFFRACTED ELECTROMAGNETIC WAVE. II. B.Karczewski.
Bull. Acad. Polon. Sci. Ser. math. astron.phys. (Poland), Vol. 8, No. 11-12, 767-72 (1960).
Previously derived formulae (Abstr. 3060 of 1961) are extended to apply to regions near the shadow boundary and not restricted to the case of the half-plane. The stationary phase method is used for approximation. The conditions are shown under which Sommerfeld's stationary phase integral can be permuted with differentiation. J.K.Skwirzynski

INCOHERENT SCATTERING OF RADIO WAVES BY A PLASMA. See Abstr. 16314

16566 SCATTERING OF ELECTROMAGNETIC WAVES BY COAXIAL FERRITE CYLINDERS OF DIFFERENT TENSOR PERMEABILITIES. Y.Chow.
Appl. sci. Res. B (Netherlands), Vol. 8, No. 4, 290-8 (1960).
The boundary value problem of the scattering of a plane electromagnetic wave normally incident on coaxial ferrite cylinders of different tensor permeabilities is investigated. The expressions for the scattered field are derived in terms of Bessel and Neumann functions of different orders.

16567 NEAR-ZONE BACK-SCATTERING FROM LARGE SPHERES. V.H.Weston.
Appl. sci. Res. B (Netherlands), Vol. 9, No. 2, 107-16 (1961).
For an incident electromagnetic plane wave, the near-zone behaviour of the backscattered field produced by a perfectly conducting sphere is investigated for small wavelengths. The backscattered cross-section becomes appreciably different when the receiver approaches to within a distance of several radii from the centre of the sphere, and in fact becomes the cross-section of a flat plate for the receiver very near the sphere.

16568 SCATTERING OF MICROWAVES FROM A CYLINDRICAL PLASMA IN THE BORN APPROXIMATION. I.
Y.Midzuno.
J. Phys. Soc. Japan, Vol. 16, No. 5, 971-80 (May, 1961).
The scattering of a plane microwave incident upon a cylindrically symmetric non-uniform plasma is treated in the Born approximation. When the electric vector is parallel to the axis of the

cylinder, the angular distribution function of the cylindrical wave scattered from a cylindrical collisionless plasma is given by

$$f(\theta) = \sqrt{\frac{\pi}{2}} e^{(3/4)\pi j} \int_0^\infty k^2 \eta(\rho') J_0\left(2k\rho' \sin\frac{\theta}{2}\right) \rho' d\rho'.$$

Here θ is the scattering angle, $\eta = (\omega_p/\omega)^2$ with the plasma frequency ω_p, and the incident wave is assumed to be proportional to $e^{j(\omega t - kx)}$. The angular distributions for other cases, e.g. waves with the electric vector perpendicular to the axis and/or plasmas with collision loss in a magnetic field, are simply related to $f(\theta)$. For some special density distributions such as that of J_0-type, the integration in $f(\theta)$ can be performed analytically. Finally the same formulae are rederived by summing the radiations from electrons wihich are forced to oscillate by the incident wave.

16569 SCATTERING OF MICROWAVES FROM A CYLINDRICAL PLASMA IN THE BORN APPROXIMATION. II.
Y.Midzuno.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1403-17 (July, 1961).

The scattering of a microwave, which is fed by an oscillating electric dipole, is treated in the Born approximation. When the source is a dipole $p_0 e^{j\omega t} e_z$, where e_z is a unit vector in the z direction, the scattered field from a collisionless cylindrical plasma is given by

$$E_S(r,t) = p_0 \sqrt{\frac{\pi}{2}} e^{(3/4)\pi j} \frac{k^4}{\sqrt{kl\rho(1+\rho)}} e^{j(\omega t - kl - k\rho)} \times$$
$$\times \int_{\rho}^{\infty} \eta(\rho') J_0\left(2k\rho' \sin\frac{\theta}{2}\right) \rho' d\rho' e_z,$$

where $(l, \pi, 0)$ and $(\rho, \theta, 0)$ are the cylindrical coordinates of the source and the observing point, respectively, $\eta(\rho')$ is ω_p^2/ω^2 with the plasma frequency ω_p and here only the term lowest in $1/kl$ and $1/k\rho$ is retained. Formulae are also derived to the next order in $1/kl$ and $1/k\rho$, when the plasma has cillision loss and the dipole source has the axis in any one of the three independent directions. Remarks and discussions are given on the nature and the accuracy of the formulae. Finally the cases, where the observing point does not lie on the plane z = 0, are treated in the lowest order in $1/kl$ and $1/k\rho$.

16570 A NOTE ON THE BACK-SCATTERING BY AN INFINITE STRIP. S.R.Seshadri.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 604-8 (Nov. 26, 1960).

The problem of scattering by an infinite strip of width 2a is considered for the case when the incident wave is a plane electromagnetic wave of wave-number k, and having its direction of propagation lying in a plane perpendicular to the strip. By employing a rigorous procedure, the first few terms in the asymptotic series of the back-scattering cross-section in inverse powers of ka are calculated for all angles of incidence.

16571 A NOTE ON THE BACK-SCATTERING OF A CIRCULAR DISK. S.R.Seshadri.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 609-16 (Nov. 26, 1960).

An asymptotic series for the back-scattering cross-section of a circular disk of radius a, when illuminated at normal incidence by a plane wave of wave-number k, is obtained up to order $(ka)^{-5/2}$ for the three cases, corresponding to (i) an acoustically hard disk, (ii) an acoustically soft disk and (iii) a perfectly conducting disk.

16572 DIFFRACTION OF A PLANE WAVE BY A UNIDIRECTIONALLY CONDUCTING HALF-PLANE. S.R.Seshadri.
Proc. Nat. Inst. Sci. India A, Vol. 27, No. 1, 1-10 (Jan. 26, 1961).

The diffraction of a plane wave by a unidirectionally conducting half-plane, a problem which has been treated previously by Karp [Research Report No. EM.108, Inst. Math. Sci., New York University] is investigated by a different method. The problem is formulated in terms of an integral equation whose solution is obtained by the standard Wiener–Hopf procedure. Expressions for the fields and the current induced on the screen are given.

16573 VERTEX-GENERATED WAVES OUTSIDE METALLIC WEDGES. W.E.Williams.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 2, 393-400 (April, 1961).

A study is made of the diffraction of e.m. waves generated by a magnetic line source placed at the vertex of a wedge of high conductivity and arbitrary angle. The boundary-value problem is reduced to the solution of a difference equation and an exact so obtained. The method is also applied to the case of dielectric-coated wedges where the surface reactance and resistance are arbitrary, and the propagation of surface waves along such sur is considered briefly. The forms of the solution for large and values of the surface impedance are obtained and show comple agreement with the known results available for a right-angled and a plane.

16574 ABSENCE OF DISPERSIVE PROPERTIES OF SPAC FOR ELECTROMAGNETIC RADIATION TESTED T $\pm 14 \times 10^{-5}$; COMMENTS ON A PROPOSAL OF SOFTKY AND SQUIRE. J.W.M.DuMond.
Proc. Nat. Acad. Sci. USA, Vol. 47, No. 3, 347-8 (March, 1961)

The proposal commented on was that a nuclear explosive s be detonated 10^6 miles from the earth so that the times of arriv of the different types of radiation could be compared over a frequency range given by a factor of 10^{11}. The comment is that test over a range of 5×10^9 is already given by the comparison the annihilation radiation wavelength (Abstr. 1084 of 1953) with 1955 values of the fundamental constants (Abstr. 2330 of 1956). J.Haw

16575 THE ZONE PLATE AS A RADIO-FREQUENCY FOCUSING ELEMENT.
L.F.Van Buskirk and C.E.Hendrix.
IRE Trans Antennas and Propagation (USA), Vol. AP-9, No. 3, 319-20 (May, 1961).

Describes some of the properties of zone plates as potenti substitutes for large paraboloids. Concludes that for certain applications they may prove useful, for example low-cost radio telescopes and space communications aerials. A.C.E

16576 BANDWIDTH OF A MOON COMMUNICATION CIRC J.V.Evans.
Brit. J. appl. Phys., Vol. 12, No. 8, 406-9 (Aug., 1961).

Radar studies of the moon by a number of workers have sh that the principal reflections occur from a region at the centre the visible disk having a radius of about one-tenth of that of the moon. Thus it is possible to use the moon as a reflector in a communication system, and several successful systems of this type have been demonstated. This paper describes measureme made at Jodrell Bank to determine the single-channel bandwidt the system using double sideband amplitude modulated transmi It is found that the demodulation of the signals caused by the m scattering at the moon's surface restricts the bandwidth to abo ±1 kc/s, although the demodulation does not appear to increase rapidly at higher modulation frequencies.

16577 THE ENERGY–MOMENTUM TENSOR OF AN ELE MAGNETIC FIELD IN AN OPTICALLY ACTIVE MEDIUM. M.Marvan.
Czech. J. Phys., Vol. 10, No. 10, 771-2 (1960).

The law of conservation of energy and of momentum, in a differential form, is formulated for a homogeneous, optically a medium, moving uniformly and rectilinearly; the analysis is an extension of that due to Fedorov (Abstr. 13195 of 1959). The te expression obtained reduces to the Minkowski energy–moment tensor for a non-active medium and at rest, it is in agreement the relations for the energy flux and energy density derived by Fedorov. J.K.Skwirz

16578 THE BOUNDARY PROBLEM FOR THE PROPAGAT OF ELECTROMAGNETIC WAVES IN A SPHERICA LAYERED, ANISOTROPIC, DISSIPATIVE MEDIUM.
P.E.Krasnushkin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 4, 813-16 (June 1, 1961). In Russian.

Maxwell's equations are formulated in a matrix-operationa form and a general case is considered, having immediate appli cation to a spherical earth consisting of layers of different propagation constants and surrounded by an anisotropic ionosp [English translation in: Soviet Physics–Doklady (USA)]. J.K.Skwirz

16579 AN ITERATION-VARIATION METHOD FOR WAVE PROPAGATION PROBLEMS.
W.J.Byatt and G.P.DeVault.
J. geophys. Res. (USA), Vol. 66, No. 6, 1793-7 (June, 1961).

In a medium in which the index of refraction varies in one

o: coordinate only, transform methods are convenient for
e. ing an inhomogeneous scalar wave equation to an ordinary
f ential equation in which the square of the space-dependent index
f raction appears explicitly. An iteration-variation method for
o ting approximate expressions for the dispersion relations
i the medium is discussed. The ordinary differential equation
; verted to an integral equation, the solution of which is begun
y ration. The individual terms in the series thereby formed,
h we shall call iterates, then form the basis of a trial function
i se in a variational principle. The method is illustrated by an
x ple.

580 CERTAIN PROBLEMS IN THE THEORY OF THE SCATTERING OF ELECTROMAGNETIC RADIATION UBMICROSCOPIC NONSPHERICAL PARTICLES.
lutsker and V.A.Marikhin.
a i Spektrosk (USSR), Vol. 10, No. 2, 232-9 (Feb., 1961).
ssian.
The scattering of electromagnetic radiation by particles, whose
ctive index does not differ greatly from that of the medium, is
idered. The influence of the nonspherical shape of the particles
e character of the angular dependence of the scattering inten-
the scattering indicatrices) is explained. Two cases of pract-
importance are analysed and compared — the scattering of
le light and of X-rays by submicroscopic particles (linear
nsions of order 10-1000 A). [English translation in: Optics
Spectrosc. (USA), Vol. 10, No. 2, 116-19 (Feb., 1961)].

581 DISTURBANCES PRODUCED BY A BODY MOVING IN A PLASMA. L.P.Pitayevskii and V.Z.Kresin.
ksper. teor. Fiz. (USSR), Vol. 40, No. 1, 271-81 (Jan., 1961).
ssian.
An expression is derived for the Fourier components n_q of the
rbance to the electron density, produced by a body moving in a
na, in the limit as the wave vector $q \to 0$. It is shown, in
cular, that the exact expression for n_q contains terms prop-
nal to $1/q$, which are absent in the first approximation of
rbation theory. The formulae are employed to calculate in
ous particular cases the effective cross-section for scattering
ectromagnetic waves of wavelengths considerably in excess of
haracteristic dimension of the body. [English translation in:
et Physics—JETP (USA), Vol. 13, No. 1, 185-91 (July, 1961)].

582 108-216 Mc/s RADIO SIGNALS FROM SATELLITES BELOW THE HORIZON. L.J.Anderson.
re (GB), Vol. 190, 708 (May 20, 1961).
Satellite transmitters at 108, 162 and 216 Mc/s were used as
al sources in an experimental programme on low-angle
action of radio waves penetrating the atmosphere. Signals
e received in the majority of passes when the satellite was well
ond the radio horizon. The combination of low attenuation and
of frequency dependence of the signal stength suggest a
ospheric ducting mechanism. Correlation of local radiosonde
with signal strength and maximum path length support this
othesis. H.Morrison

583 ON THE GENERALIZATION OF THE APPLETON–HARTREE MAGNETOIONIC FORMULAS.
.Sen and A.A.Wyller.
eophys. Res. (USA), Vol. 65, No. 12, 3931-50 (Dec., 1960).
The complex refractive index and the state of polarization in a
kly ionized gas with an alternating electric field and a steady
netic field are given by the ordinary Appleton–Hartree
nulae. In the original derivation a "frictional" term is utilized
ch is assumed to be independent of the electron velocity, v, and
electron velocity distribution. It represents a first approxi-
ion to an effective collision frequency, ν_{AH}, for the collisions
veen electrons and neutral molecules. The present work is an
ension of Jancel and Kahan's magnetoionic theory (Abstr. 4822
955), which is based upon solutions of the Boltzmann equation,
n $\nu = \nu_m f(v)$. The expression for the complex refractive index
the state of polarization are rederived, utilizing a generalized
ductivity tensor for the Lorentz gas. The resulting solutions are
wn to be identical with the ordinary Appleton–Hartree formulae
en ν = constant. In the general case, $\nu = \nu_m f(v)$, a new angular
endent term appears, the coefficient of which vanishes, when
constant. The elements of the generalized conductivity tensor
integrals involving the electron velocity distribution function.
general non-Maxwellian distribution function for the electrons
is derived as a function of the alternating electric field and a steady magnetic field, when the two field vectors have an arbitrary inclination to each other. In the ionospheric wave propagation, the electrons are assumed to have a Maxwellian velocity distribution, as the electric and magnetic field effects will be negligible. The elements of the generalized conductivity tensor are then expressible in terms of previously tabulated integrals, when use is made of Phelps and Pack's laboratory results, viz., $\nu \propto v^2$ in air (Abstr. 3350 of 1960). This greatly eases the computational use of the generalized formulae. Calculations are carried out for longitudinal and transverse propagation in the cases,

$$\nu_{AH} = \nu_m = \tfrac{1}{10}\omega,$$

$$\nu_{AH} = \nu_m = \omega/2,$$

and

$$\nu_{AH} = \nu_m = 2\omega,$$

and with s (electron gyrofrequency) the same order of magnitude as ω. Generally the birefringent properties of the medium are decreased, when the velocity dependence of the collision frequency is taken into account through the general theory. In all cases the absorption factors based on the generalized theory differ from those based on the ordinary Appleton–Hartree formulae by amounts from 30 to 100%. Improved agreement is obtained when ν_{AH} in the Appleton–Hartree formula is associated with the mean energy instead of the most probable energy as in the generalized theory; i.e. when $\nu_{AH} = \frac{3}{2}\nu_m$ instead of $\nu_{AH} = \nu_m$. In the asymptotic limit, $\nu \ll \omega \pm s$, the ordinary Appleton–Hartree formula can be retained, provided that

$$\nu_{AH} = \tfrac{5}{3} \times \tfrac{3}{2}\nu_m = \tfrac{5}{2}\nu_m.$$

In the other asymptotic limit, $\nu \gg \omega \pm s$, these same formulae can also be retained when $\nu_{AH} = \frac{3}{2}\nu_m$. For the intermediate case, $\nu \sim \omega \sim s$, differences in the absorption factors between the two theories persist with amounts up to 100% even though $\nu_{AH} = \frac{3}{2}\nu_m$. It is concluded that the generalized theory should be utilized in this case for all precise experimental work.

16584 RADIO-WAVE SCATTERING BY AN IONIZED GAS IN THERMAL EQUILIBRIUM. J.A.Fejer.
J. geophys. Res. (USA), Vol. 65, No. 9, 2635-6 (Sept., 1960).
Expressions for the power density and the power spectrum of radio waves scattered by the density fluctuations of an ionized gas in thermal equilibrium are presented. These expressions are applicable to the terrestrial ionosphere and are in agreement with results obtained by an UHF radar.

16585 SCATTERING OF ELECTROMAGNETIC WAVES FROM A NONDEGENERATE IONIZED GAS.
J.Renau.
J. geophys. Res. (USA), Vol. 65, No. 11, 3631-40 (Nov., 1960).
On the basis of a derived Coulomb interaction function, which takes into account the effect of the electrons and the positive ions, a rigorous theory of electromagnetic scattering for a nondegenerate ionized gas in thermal equilibrium is obtained. Moreover, it is shown that by smearing the positive ions in the background and ignoring the background (a model used by Pines and Bohm [1952] and Akhiezer, Prokgoda, and Sitenko, [1958]) one obtains a scattering cross-section incompatible with ionospheric experimental observations [Bowles 1959]. Electromagnetic wave scattering from an ionized gas in nonlaminar flow is also considered. The analysis shows that, if the operating wavelength is much smaller than the smallest eddy size, the mass motion may be neglected and the scattering will be due to the thermal source only. On the other hand, when the wavelength is much greater than the smallest eddy size, the scattering from the nonlaminar fluctuations may dominate the fluctuations from the thermal source if the intensity of turbulence is sufficiently strong. The expected frequency spectrum of the echoes from an ionized gas in turbulent motion is discussed briefly.

16586 ON THE EVALUATION OF THE GROUP REFRACTIVE INDEX IN CASE OF NO COLLISIONS. H.Unz.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3. 189-94 (March, 1961).
An alternative method is shown for the evaluation of the group refractive index μ' in case of no collisions. An asymptotic form

near the reflection point X = 1 is derived. Both of the expressions are simpler and more suitable for calculations than the ones given by Shinn and Whale (Abstr. 3692 of 1954).

16587 THE SCATTERING OF RADIO WAVES BY AN EXTENDED RANDOMLY REFRACTING MEDIUM.
S.A.Bowhill.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 1, 9-18 (Feb., 1961).

A continuous medium containing three-dimensional random inhomogeneities of refractive index scatters an electromagnetic wave which is incident upon it. This paper derives the form of the emerging angular power spectrum of the wave, for the case where the scales of the inhomogeneities are different in the three spaced directions. It is shown that the medium cannot be analysed as a series of superposed thin phase screens, spaced in the propagation direction, and with independent phase profiles. When a limiting process is carried out, allowing for an arbitrary spatial correlation function for the inhomogeneities in the three directions, a quite different result is obtained. This disparity is due to diffractive changes in the wave in passing from one inhomogeneity to the next.

16588 INFLUENCE OF THE TOTAL ECLIPSE OF THE SUN ON FEBRUARY 15th 1961 ON THE TRAVEL TIME OF VERY LONG WAVES.
B.Decaux, A.Gabry, J.Lachâtre and J.Lucas.
C.R. Acad. Sci. (France), Vol. 252, No. 16, 2387-9 (April 17, 1961).
In French.

The phase and amplitude of the signals from two standard low-frequency broadcast stations, and atmospherics at 27 kc/s, were observed. Effects during the eclipse are described and it is shown that the eclipse produces night-time propagation conditions.
H.J.A.Chivers

16589 OBSERVATIONS OF UNUSUAL LOW-FREQUENCY PROPAGATION MADE ON 12 NOVEMBER 1960.
J.S.Belrose and D.B.Ross.
Canad. J. Phys., Vol. 39, No. 4, 609-14 (April, 1961).

Details of measurements of the effects on the propagation of l.f. waves following the class 3+ flare on 12 Nov. 1960. During the peak of the disturbance, electron densities and electron density gradients appear to have been produced near 60 km altitude adequate to reflect l.f. waves. G.M.Brown

16590 SOLUTION OF THE BOUNDARY VALUE PROBLEM FOR PROPAGATION OF RADIO WAVES ROUND THE EARTH, WHILE TAKING INTO ACCOUNT GENERAL GEOPHYSICAL FACTORS. P.E.Krasnushkin.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1055-8 (June 11, 1961).
In Russian.

The total spectrum of such waves is derived for a three-layer model: (1) $0 \leq r \leq a$ (a = earth's radius) with a complex dielectric constant; (2) $a \leq r \leq c$, ideal atmosphere with unity dielectric constant; (3) $c \leq r < \infty$, ionosphere, considered as an electron–ion plasma under the influence of steady magnetic field. Special cases are also considered: (1) Watson's case of a spherical waveguide; (2) plane waveguide model ($a \to \infty$); (3) diffraction model; (4) Sommerfeld model. [English translation in: Soviet Physics–Doklady (USA)]. J.K.Skwirzynski

16591 ANALYSIS OF RANDOM FADING RECORDS.
S.R.Khastgir and R.N.Singh.
Indian J. Phys., Vol. 34, No. 11, 527-30 (Nov., 1960).

The analysis of the three-spaced-receiver fading records taken at Banaras from Nov. 1956 to March 1958 with vertically-directed pulse transmission on 3.8 Mc/s yielded the following results: (1) The ratio of the drift velocity v_ω to the r.m.s. line-of-sight velocity v_0 of the ionospheric irregularities is not found to be constant, as is expected from theory. The ratio increases with the increasing drift velocity. (2) The ratio of the drift velocity v_ω to the product of the frequency of fading N and the wavelength λ is not found to be constant, as is expected from theory. The ratio decreases with the increasing drift velocity. (3) The angle of spread of the scattered components from the ionospheric irregularities obtained from $\theta_0 = \sin^{-1}(N.\lambda/2v_\omega)$ is found to increase with the increasing drift velocity.

16592 BEHAVIOUR OF BROADCAST FREQUENCY WAVES AT OBLIQUE INCIDENCE DURING AN ANNULAR ECLIPSE.
R.K.MacCrone and F.R.N.Nabarro.
J. atmos. terrest. Phys. (GB), Vol. 20, No. 2-3, 200-5 (March, 1961).

Measurements taken during a solar eclipse show discontinuities in the absorption of obliquely incident waves in the broadcast band. The results are consistent with Appleton's explanation in terms an abrupt change in the height of the point of reflection. Some dence for a corpuscular eclipse 2 hr before the peak of the opt eclipse is also presented.

16593 THE NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS GOVERNING THE REFLEXION OF D RADIO WAVES FROM THE IONOSPHERE. IV. D.W.Barron,
Proc. Roy. Soc. A (GB), Vol. 260, 393-408 (March 7, 1961).

For Pt III see Abstr. 7233 of 1960. The previous papers series have described methods by which the differential equati governing the reflection of long waves from the ionosphere m solved with the use of an automatic digital computer, and have dealt with the application of these methods to some idealized sphere models. In this paper these methods are used in a com ive study of models which have been proposed for the day-time ionosphere in summer. The model whose theoretical reflecti properties most nearly agree with the experimental observati found, and suggestions are made as to how it should be change summary is given of the essential properties which an acceptab day-time ionosphere model must possess. The transition fro time to night-time conditions in the ionosphere is also discuss and it is shown that the sharp change in the reflection coeffici can be accounted for qualitatively by the disappearance of a D which might be present during the day at low level in the iono

ABSORPTION OF RADIO WAVES IN D_1 AND D_2 LAYERS THE IONOSPHERE. See Abstr. 15272

Radiofrequency Spectroscopy Techniques

16594 A BEAM MASER SPECTROMETER.
P.Thaddeus and L.C.Krisher.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1083-9 (Oct., 1961).

The construction and operation of a molecular beam mas spectrometer, similar to the ammonia maser, is described. observed linewidths are of the order of 5 kc at microwave frequencies, thereby allowing high resolution hyperfine spectr scopy on a number of molecules. The major factors affecting resolution and sensitivity are examined. A brief survey of possible experiments is given.

16595 IMPROVEMENT OF THE SENSITIVITY OF MICRO WAVE VIDEO SPECTROMETERS BY REDUCTION NOISE. A.Gozzini and M.Iannuzzi.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 178-82 (19
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). shown that the sensitivity of a video microwave spectrometer increased by placing several identical systems of absorption crystal diode and video amplifier in parallel. By placing 16 u parallel the signal-to-noise ratio is improved by a factor of 4 parallel systems also allow the use of klystron power more efficiently, before saturation occurs, and they average out the standing waves which otherwise form a practical limit to the such spectrometers. In addition it is demonstrated that the e lent noise resistance of N amplifiers in parallel is almost N t smaller than that of a single one, and that the effects of micro phonics are reduced considerably. F

16596 ABSOLUTE DETERMINATION OF THE NUMBER FREE ELECTRONS USING AN ELECTRON PARA MAGNETIC RESONANCE SPECTROMETER. J.Smidt.
Arch. Sci. (Switzerland), Vol. 13, No. Fasc. Spec., 337-41 (19
In French.

9th Colloque Ampère Paper (see Abstr. 4734 of 1961). Relations are derived for the determination of the number of unpaired electrons contributing to the paramagnetic resonanc signal. The relations are derived directly from microwave cavity relations without the use of equivalent circuits and are also independent of detector power law. Relations are given for transmission and reflection cavities. P.E.

ON THE MINIMUM DETECTABLE CHANGE OF A LARGE SIGNAL AND ITS APPLICATION TO THE TIVITY OF MICROWAVE AND E.P.R. SPECTROMETERS.
tiller.
Sci. (Switzerland), Vol. 13, No. Fasc.Spec., 342-6 (1960).
h Colloque Ampère Paper (see Abstr. 4734 of 1961). It is that since the minimum detectable signal change for a large in any spectrometer involves comparison of the signal ise powers the minimum detectable signal change should ependent of detector type. Relations are given for gas and spectrometers that give the minimum detectable absorption ient and susceptibility respectively. It is also shown that is only one optimum cell length or cavity coupling coefficient.
P.E.Seiden

HIGH FREQUENCY MODULATION IN ELECTRON SPIN RESONANCE. J.G.Théobald and J.Uebersfeld.
s. Radium (France), Vol. 21, No. 8-9, 676-7 (Aug.-Sept., In French.
n arrangement to modulate the magnetic field of a 3 cm ength spectrometer at about 100 kc/s is described. An vement of 5-10 over the sensitivity with 50 c/s modulation otained.
D.Walsh

MAGNETIC RESONANCE — A SPECTROMETER FOR PARAMAGNETIC RESONANCE WITH VARIABLE HIGH UENCY MODULATION. J.G.Théobald and J.Uebersfeld.
Acad. Sci. (France), Vol. 252, No. 20, 3030-2 (May 15, 1961).
nch.
n arrangement is described for observing paramagnetic ance signals with a high frequency (up to 1.1 Mc/s) field.
D.Walsh

APPARATUS FOR THE STUDY OF THE ELECTRON PARAMAGNETIC RESONANCE IN CIRCULAR TATION. APPLICATION TO THE STUDY OF SOLUTIONS OF IUM IN LIQUID AMMONIA. A.Charru.
Phys. (France), Vol. 5, No. 11-12, 1449-99 (Nov.-Dec., 1960).
nch.
The theoretical basis and the practical construction of a rometer for the measurement of electron paramagnetic ance in circular excitation is described in considerable detail. rvations on solutions of lithium in ethylamine and in ammonia st the presence of $Li(NH_3)_4$ in equilibrium with Li. Effects of erature and of ageing of the solutions have been studied.
G.I.W.Llewelyn

A NEW METHOD OF MEASURING PARAMAGNETIC AND FERROMAGNETIC RESONANCE. J.Dušek.
n. J. Phys., Vol. 11, No. 7, 528-39 (1961).
Gives a brief analysis and description of a new method of uring paramagnetic and ferromagnetic resonance on centi- e waves, which permits automatic and exact adjustment of the ron frequency to the frequency of the cavity, continuous re- ng of the spectral lines and recording point by point. The ciple is suitable for all microwave bands. The sensitivity and lity of the spectrometer, constructed on the basis of this od, satisfies requirements for measurement in the region of magnetic and ferromagnetic resonance. In the arrangement (the unloaded Q-factor $Q_0 \cong 4000$), the smallest reliably surable width of the absorption lines is around 10 Oe.

A SYSTEM FOR STUDYING ELECTRONIC RESONANCE OVER A WIDE TEMPERATURE RANGE.
Galkin and D.A.Kichigin.
Pry i Tekh. Eksper. (USSR), 1958, No. 3, 71-2 (May-June).
ssian.
A modification of the Zavoiskii [Journal of Physics (USSR), 9, 245 (1945)] method for observing e.s.r. at frequencies less 500 Mc/s is described in which it is possible to take account of hange in sensitivity of the system due to changes in temperature oscillation conditions. The technique can be used to measure ntensities of e.s.r. signals at different temperatures by a parison of the magnitude of the e.s.r. signal, which depends on the circuit inductance, with the size of a similar signal, due of a semiconductor in the circuit capacitance. As the latter al changes only because of the different operating conditions, rms a standard with which the sensitivity of the spectrometer be calibrated. [English Translation in: Instrum. exper. Tech.), No. 3, 396-7 (May-June, 1958; publ. June, 1959)].
J.M.Baker

A SPECTROGRAPH WITH FREQUENCY MODULATION FOR NUCLEAR MAGNETIC RESONANCE IN FERROMAGNETICS. J.N.Aubrun.
C. R. Acad. Sci. (France), Vol. 252, No. 25, 3980-2 (June 19, 1961).
In French.
A frequency modulation is provided with an amplitude greater than the bandwidth of the resonant circuit. The circuit output is then a series of pulses whose shape is just that of the resonance curve of the circuit. The peak amplitude is then detected and displayed as a function of frequency on an oscilloscope. The variation of frequency for the oscilloscope display is at a much slower rate than the frequency modulation which provides the peak detected pulses so that the detection provides values at an essentially fixed frequency. This spectrograph can detect nuclear resonance in less than 1/2 gram of cobalt.
P. E.Seiden

THE VALIDITY OF THE ELECTRIC MODEL REPRESENTATION OF THE EFFECTS OF NUCLEAR MAGNETIC RESONANCE. G.Bonnet.
J. Phys. Radium (France), Vol. 22, No. 4, 204-14 (April, 1961).
In French.
When studying the behaviour of a magnetic resonance transducer formed by the association of an electrical network and a set of nuclear spins, it is possible to use a representation that is analytically equivalent to an entirely electrical model, available for both the transient and the steady states. A detailed study of the validity conditions justifies its use in most cases. Also proposed is a criterion of linearity of Bloch's equations for the transient state that is simply an extension of the well-known non-saturation condition in the steady state.

APPLICATION OF A SYNCHRONIZED AUTODYNE FOR STUDYING NUCLEAR MAGNETIC RESONANCE SPECTRA. Yu.S.Konstantinov.
Pribory i Tekh. Eksper. (USSR), 1958, No. 2, 105 (March-April).
In Russian.
When sufficiently narrow n.m.r. lines are investigated by a self-oscillatory system, considerable distortion of the line shape can occur owing to trailing effects. This distortion was practically eliminated by synchronizing the oscillator with an external crystal oscillator. The signal-to-noise ratio is practically unaffected by this synchronization. [English translation in: Instrum. exper. Tech. (USA), No. 2, 296-7 (March-April, 1958; publ. April, 1959)].
J.M.Baker

SPIN DECOUPLING IN HIGH RESOLUTION PROTON MAGNETIC RESONANCE R.Freeman.
Molecular Phys. (GB), Vol. 3, No. 5, 435-9 (Sept., 1960).
A simple unit is described which can be incorporated in a high-resolution nuclear magnetic resonance spectrometer to remove the spin coupling between two groups of hydrogen nuclei in the same molecule. Applied to the molecule of propionaldehyde, the method considerably simplifies the analysis of the high resolution spectrum measured at 60 Mc/s.

A METHOD FOR THE MEASUREMENT OF LONG SPIN—LATTICE RELAXATION TIMES. M.Santini.
Nuovo Cimento Suppl. (Italy), Vol. 16, No. 2, 232-9 (1960).
The method is based on a series of adiabatic fast passages and is particularly convenient in the case of exceptionally long times.

FAR INFRARED AND MICROWAVE DETECTOR. D.W.Goodwin and R.H.Jones.
J. appl. Phys. (USA), Vol. 32, No. 10, 2056-7 (Oct., 1961).
Cyclotron resonance absorption of radiation at 34 kMc/s results in a change in the conductivity of a specimen of n-type Ge due to an increase in the electron temperature. This is the basis of a detector. The responsivity of a detector of area 2 mm^2 was 2×10^4 $\mu V/\mu W$ and the normalized detectivity for 1 cm^2 and unit cycle bandwidth was 10^{11} W^{-1}. It is considered that a detectivity not exceeding 10^{14} W^{-1} could be achieved. The speed of response was 6×10^{-10} sec. A possible detector working at 200 μ is suggested.
D.J.Oliver

SYNCHRONOUS DETECTOR USING THE 7360 BEAM-DEFLECTION TUBE. A.Sobel.
Rev. sci. Instrum. (USA), Vol. 32, No. 7, 867-8 (July, 1961).
A detailed circuit suitable for use with a n.m.r. spectrometer is described, that uses the 7360 beam deflection tube.
D.Walsh

NUCLEAR PHYSICS

16610 PROCEEDINGS OF THE RUTHERFORD JUBILEE INTERNATIONAL CONFERENCE ON NUCLEAR PHYSICS. Edited by J.B.Birks.
London: Heywood (1961) 852 pp.

The conference which was sponsored by IUPAP the Royal Society, the Institute of Physics and the Physical Society and the University of Manchester was held at Manchester on Sept. 4-8, 1961. There were nine sessions including a commemorative one on "Rutherford at Manchester". The Proceedings contain 23 invited papers and 180 contributed papers. Topics covered included: high-energy investigations of nuclei; collective motion in nuclei; the nuclear ground-state; direct interactions; weak interactions. Abstracts of some of the papers will be found in subsequent issues of Physics Abstracts.

16611 THE EXPONENTIAL DECAY LAW OF UNSTABLE SYSTEMS. R.G.Newton.
Ann. Phys. (USA), Vol. 14, No. 1, 333-45 (July, 1961).

It is shown that associated with any sufficiently sharp resonance there is a delayed emergence of particles that under suitable conditions follows an exponential law of decay to an excellent approximation over many lifetimes. The dependence of the duration of the exponential curve on the resonance width, on the excitation width, and on the observation distance, is examined in detail.

NEW ELEMENT, LAWRENCIUM, ATOMIC NUMBER 103.
See Abstr. 13700

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

16612 AN IMPROVED ANTI-COINCIDENCE SHIELD FOR USE IN LOW BACKGROUND COUNTING. R.P.Parker.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 339-43 (Sept., 1960).

A liquid scintillator is used as an anticoincidence shield for eliminating the cosmic ray component of the background of a Geiger–Müller (G.E.C. Type GM 4 LB) counter. The apparatus is described and its performance compared with that of a shield of Geiger counters. A reduction in background from approximately 0.8 counts/min (as measured with the Geiger shield) to approximately 0.45 counts/min as measured with the scintillator shield, was obtained. Evidence is presented which suggests that the reduction is due to the detection of cosmic ray induced reactions in the material surrounding the counter.

16613 A NEW TYPE OF LIQUID ANODE GAMMA AND BETA HALOGEN COUNTER. S.C.Pancholi.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 118-19 (Oct., 1960).

A new type of radiation counter is described which uses a thin glass tube filled with conducting water as the anode. This type of halogen counter is characterized by a fairly good plateau slope and a large plateau width. The preliminary findings are described.

16614 THE "RADIUS EFFECT" IN LARGE BF_3 COUNTER TUBES. J.Gordon and P.Szabó.
Acta. phys. Hungar., Vol. 12, No. 4, 333-4 (1960).

Results obtained with large diameter (5-6 cm) BF_3 proportional counters are discussed. In contrast to earlier work it is shown that, in these counters, the efficiency is constant up to a distance of 2 cm from the anode wire. This makes the counters particularly suitable for use in neutron diffractometers. It is suggested that the discrepancy between these results and those of earlier workers is due to the insufficient purity of the counters used by the latter.

C.F.Barnaby

16615 PLASTIC SCINTILLATORS. J.Andruszkiewicz, W.Kuźma and Z.Polacki.
Nukleonika (Poland), Vol. 5, No. 9, 575-82 (1960). In Polish.

Plastic scintillators p-terphenyl + POPOP in polystyrene produced. The dependence of detection efficiency upon compo of scintillators was investigated in order to find the optimum centrations of ingredients. It was confirmed, that, when using photomultiplier FEU-19, the optimum composition is 3% p-ter and 0.025% POPOP. The dependence of detection efficiency on scintillator size was investigated. The efficiency (pulse heigh the plastic scintillators was 0.44 that of antracene.

16616 A NEW METHOD OF MASS DISCRIMINATION. G.Hrehuss.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 344-7 (Sept., 1960).

Emission spectra of CsI:Tl scintillation crystals bombard heavy as well as light particles were investigated. The result the number of photons of shorter wavelength to be relatively h in the case of excitation by light particles. This fact offers a possibility for mass discrimination.

16617 A NEW TYPE OF ČERENKOV DETECTOR FOR T ACCURATE MEASUREMENT OF PARTICLE VEL AND DIRECTION. A.Roberts.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 55-66 (Oct., 1960).

A new type of Cherenkov radiation detector is proposed, i which the light emitted by a single particle traversing a radia imaged, by means of a lens or mirror focused at infinity, on t cathode of an image-intensifier tube. The image is a ring, wh diameter measures accurately the Cherenkov cone angle, and the particle velocity. In addition the coordinates of the centre circular image accurately indicate the orientation of the parti trajectory (though not its position). The sensitivity of present available systems of cascaded image-intensifier tubes allows photographic recording of the image produced by a single part The system is inherently insensitive to background noise. It c observe simultaneously several incident particles whose direc span a wide angle. It may be gated with microsecond coincide resolving times. It can use condensed or gaseous radiators; w the former, chromatic dispersion is likely to limit the accura For gas radiators, the attainable accuracy of velocity determi is estimated as $\Delta\beta = \pm 0.0002$ or better; the accuracy of track o tion ± 0.001 radians. The range of velocity and orientation sim taneously observable depends on the angular field of view of th jective. Sources of error, the precision attainable, the design practical systems and some possible applications are discuss

16618 SOLID STATE DETECTORS FOR HIGH RESOLUT NUCLEAR SPECTROSCOPY.
W.C.Parkinson and O.M.Bilaniuk.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1136-42 (Oct., 1961)

Use of an array of solid-state detectors in conjunction wi magnetic analyser as a replacement for nuclear emulsions in nuclear spectroscopy is described. Arrays of both Au–Ge an gold-doped silicon were used. The arrays consist of twenty detectors each and cover two inches along the image plane of magnetic spectrograph. Particles of the same magnetic rigidi but different mass, are easily identified as their energies are the ratio Z^2/m. The silicon detectors, which operate essentia as parallel plate ionization chambers, suffer the disadvantage becoming polarized. The use of such arrays reduces by a fac of the order of twenty the time required to extract precision d from a nuclear reaction.

16619 SIGNAL-TO-NOISE RATIO OF A P–N-JUNCTION RADIATION COUNTER. J.A.W.van der Does de B
Philips Res. Rep. (Netherlands), Vol. 16, No. 1, 85-95 (Feb., 1

With a p–n diode of low capacitance X-ray quanta can be counted. They generate electron–hole pairs in the space-cha layer between the n and p regions of a reversely biased diode. complete collection of the charge so generated makes radiatio spectrometry possible. This paper deals chiefly with the sign noise ratio of the p–n counter. It is found that the spectral li width caused by noise can be reduced to 3 keV and the discrim

...set at 6 keV to reject most of the noise. These values are ...ated for the case of a thermionic amplifier with RC pulse ...ng and are determined mainly by the diode current noise, the ...hot noise and the total input capacitance, which together ...itute a figure of merit for the p–n counter. The values found ...imentally were about 1.5 times higher.

...ETA COUNTING USING DIAMONDS. See Abstr. 14210

16620 CONSTRUCTION AND SET UP OF A 4π FLOW COUNTER.

...íriguez Máyques, A.Morales Villasevil and R.Núñez-Lagos.
...eal Soc. Espan. Fiz. Quim. (Spain), Vol. 56A, No. 7-8, 207-11 ...-Aug., 1960). In Spanish.

The construction of the counter, which was filled with 96% A ...% CO_2, is described and conditions for optimum performance ...iscussed. The length of a typical plateau obtained with a ...S^{35} source was 150 V and its slope 0.3% per 100 V.

I.C.Demetsopoullos

16621 THERMOLUMINESCENCE AND DOSIMETRY IN SAMARIUM-ACTIVATED $CaSO_4$. H.Peter.

...kernergie (Germany), Vol. 5, No. 12, 453-5 (Dec., 1960). ...erman.

The phosphorescent substance $CaSO_4$: Sm was tested for its ...bility as a thermoluminescent dosimeter. The dependence ...e thermoluminescence on the conditions of manufacture ...pering, effect of activators, glowing atmosphere) was investi- ...d. The phosphorescent substance shows a good proportionality ...ion between the dose and total light intensity from 0.005 to ...r. The energy storage is quite satisfactory.

16622 STOPPING POWERS FOR USE WITH CAVITY CHAMBERS.

...b.Nat. Bur. Stand. (USA), No. 79, 85 pp. (1961).

Presents a critical review of the literature concerning the ...ping power ratio that is used in the interpretation of cavity- ...ation measurements in radiation dosimetry. The cavity ...ber theory is discussed in detail. A review of the theory and ...rimental information on ranges and stopping powers of charged ...cles is then made. The information available from cavity ...ber measurements is reviewed and compared with theory. ...lly, conclusions as to the best currently available information ...t stopping power ratios are made. An extensive bibliography ...ven.

C.F.Barnaby

16623 A BISMUTH LEAD BORATE GLASS DOSIMETER FOR HIGH-LEVEL GAMMA MEASUREMENTS. A.M.Bishay.

...s. Chem. Glasses (GB), Vol. 2, No. 2, 33-8 (April, 1961).

A bismuth lead borate glass dosimeter for high-level gamma ...surements has been developed. This glass has a wider range of ...sitivity and much less fading of the induced coloration than ...ting dosimeter glasses. When a bismuth lead borate glass con- ...ng a little As_2O_3 is subjected to gamma radiation an absorption ...d is induced at about 515 mμ (2.4 eV). This absorption band is ...ced only in those glasses containing both As^{3+} and Bi^{3+}. It is ...ulated that a photochemical reaction, in which Bi_2O_3 is reduced ...ismuth by As_2O_3, is responsible for the induced absorption band ...15 mμ. Heating the glass to about 130° C was found to decrease ...contribution of the induced u.v. band to absorption in the visible. ...ass containing 52% Bi_2O_3, 24% B_2O_3, 17% PbO, 4.5% SiO_2, and ...As_2O_3 (by wt.) was tested in the exposure range of 10^5 to 10^9 r ...cident gamma-radiation. A linear relationship was obtained ...een the logarithm of the induced optical density at the centre of ...oand and the logarithm of the total exposure.

16624 THE PILE-UP OF PULSES IN SCINTILLATION SPECTROMETRY WITH HIGH PULSE RATES.

...runner.
...nkernenergie (Germany), Vol. 5, No. 12, 456-8 (Dec., 1960). ...erman.

Simple considerations of the shape and statistics of pulses may ...ain as a pile-up of pulses the weak maxima in scintillation ...trographs at the double energy of real emission lines, or at ...sum of energies of two lines, of the radioactive sources ...erned. The effects of pulse rates and the collecting time and ...y time of pulses may be neglected in a formula which is ...erimentally confirmed. From the variation of pile-up abundance ...temperature there follows an increase in decay time of pulses ...n NaI(Tl) with increasing temperature involving a factor of ...roximately two for a 60 deg C interval in the region of 0° C.

16625 ERRORS DUE TO THE "DEAD" TIME OF COUNTERS OPERATING IN CONJUNCTION WITH PULSED SOURCES. I.A.Grishaev and A.M.Shenderovich.

Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 410-16 (Aug., 1961). In Russian.

Expressions are derived for the mean counting rate, mean counting loss rate, dispersion of a number of counts, and dispersion of a number of missed counts for various relations between the "dead" time, pulse duration, and pulse repetition rate. It is shown that the errors due to the "dead" time depend sharply on the relation between these quantities. The formulae derived can be used to evaluate the experimental errors due to the "dead" time. {English translation in: Soviet Physics–JETP (USA)}.

16626 HIGH-PRESSURE HYDROGEN GAS TARGET. J.Kirk.

J. sci. Instrum. (GB), Vol. 38, No. 11, 439-41 (Nov., 1961).

A description is given of a hydrogen gas target, which has been designed to operate at a pressure of 450 lb/in^2 and at a temperature of −70° C, to be used in studies of X-ray scattering from hydrogen using a nuclear photograph emulsion technique. The choice of material for the entrance window and the high-pressure sealing of flanges is discussed.

Track Visualization

16627 AN INTERNAL-COUNTER-CONTROLLED LOW-PRESSURE CLOUD CHAMBER. M.Rama Rao.

Indian J. Phys., Vol. 35, No. 7, 361-73 (July, 1961).

A low-pressure internal-counter-controlled cloud chamber operating at a pressure of 8 cm of Hg is described. The details of the electronic circuitry for running the chamber automatically are also presented.

16628 A SELF-TRIGGERED WILSON CLOUD CHAMBER OF VARIABLE PRESSURE (1 - 76 cm Hg) OF A NEW TYPE. T.Yuasa.

J. Phys. Radium (France), Vol. 21, No. 5, 495-501 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). With a view to studying phenomena concerning charged particles of very short range, a self-triggered cloud chamber with an adjustable pressure between 1 cm Hg and 76 cm Hg was constructed. Low pressure working characteristics of this chamber are given.

16629 A SEMI-AUTOMATIC APPARATUS FOR EVALUATING STEREOSCOPIC CLOUD CHAMBER PHOTOGRAPHS. T.Holtwijk.

Ned. Tijdschrift. Natuurkde (Netherlands), Vol. 26, No. 5, 150-2 (May, 1960). In Dutch.

A stereo-viewing system is described for determining the position coordinates of cloud-chamber tracks from stereophotographs. The two stereo-plates are projected on to a screen. The Z-coordinate of a given point on the track is determined by superimposing the two images and the X- and Y-coordinates determined by moving a positioning mark on to the point. The position coordinates are converted to an electric signal which in turn is fed into a "Zebra" computer. The equipment has been used in conjuction with a 5 MeV betatron.

A.E.I. Research Laboratory

16630 A SEMI-AUTOMATIC ANALYSER FOR BUBBLE CHAMBER PHOTOGRAPHS. O.R.Frisch and A.J.Oxley.

Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 92-6 (Oct., 1960).

Photographs of nuclear particle tracks can be accumulated rapidly with fast-cycling bubble chambers. This article describes a machine for measuring the photographs quickly so that the subsequent computation can be done with an electronic computer. The films are projected onto a ground glass screen bearing a reference mark, and moved by hand through a pantograph to bring interesting points onto the mark. The pantograph carries a plate with a fine square lattice of dots, and four photocells serve to digitize its X and Y coordinates. The two stereoscopic images of a point can be merged by moving one of the projection lenses; this motion also is digitized photoelectrically. After setting each point, the measured

data are punched on tape, to be fed later to an electronic computer. The design, operation, and performance of the machine are described in some detail, together with the principles of measurement and some proposed improvements.

16631 USE OF SPARK CHAMBERS IN MAGNETIC FIELDS. G.R.Burleson, A.Roberts and T.A.Romanowski.
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1069-70 (Sept., 1961).
The assumption that spark chambers would be useless for tracks making a large angle with the normal to the plates is shown to be incorrect. Tracks were obtained of particles deflected in a magnetic field, moving parallel to the plates. An efficiency per gap of 95% (with single tracks) was obtained. J.L.Redding

NUCLEAR EMULSIONS IN THE I.G.Y. See Abstr. 16921

16632 ON THE EFFECT OF THE AGEING TIME OF THE DEVELOPER ON NUCLEAR EMULSION BACKGROUND. J.Benisz and W.Chodźba.
Acta phys. Polon. (Poland), Vol. 20, No. 3, 269-71 (1961).
In order to prevent undue background fog formation it is suggested that developer aged for $1\frac{1}{2}$ to 3 days be used to develop nuclear emulsions. S.J.St-Lorant

16633 RANGE OF PROTONS IN THE AGFA K2 NUCLEAR EMULSION. L.Medveczky and G.Somogyi.
Acta phys. Hungar., Vol. 13, No. 2, 163-7 (1961).
By measuring the range versus energy curve of recoil protons produced in the nuclear emulsion by reactions $H^2(d, n)$ He^3 and $H^3(d, n)$ He^4, calibration points were obtained to determine the range–energy relation of the Agfa K2 emulsion. The measured ranges showed good agreement within the error limits with results of calculations for Agfa K2 emulsion containing 60% relative humidity (Abstr. 5460 of 1960).

16634 SOME ASPECTS OF TRACKS DUE TO IONIZING PARTICLES IN PHOTOGRAPHIC EMULSIONS OF LOW SENSITIVITY. M.Ader and M.P.Houard-Cabannes.
J. Phys. Radium (France), Vol. 22, No. 1, 61-2 (Jan., 1961). In French.
A qualitative study of the appearance of proton tracks of several MeV was made in normal and in boron-loaded Ilford K0, K1 and K2 emulsions. See also following abstract. S.J.St-Lorant

16635 SOME ASPECTS OF TRACKS DUE TO IONIZING PARTICLES IN PHOTOGRAPHIC EMULSIONS OF LOW SENSITIVITY (CONTINUED). M.Ader and M.P.Houard-Cabannes.
J. Phys. Radium (France), Vol. 22, No. 2, 123-4 (Feb., 1961). In French.
The examination of tracks in emulsions of low sensitivity (see preceding abstract) was extended to α-particles from ThC' contained in Ilford K1 and K2 emulsion. The qualitative characteristics of the tracks are discussed. S.J.St-Lorant

16636 REMARKS ON THE USE OF POWDERS IN NUCLEAR EMULSIONS. Cao xuan Chuan and Nguyên bich Nhu.
J. Phys. Radium (France), Vol. 22, No. 7, 459-60 (July, 1961). In French.
A theoretical expression is derived to take into account the fact that the origin of an interaction in a grain of nuclear emulsion loaded with powder is not visible. A correction is deduced for the case when the secondary particles of an interaction in a powder grain do not have sufficient energy to escape from the grain. S.J.St-Lorant

16637 A SIMPLE GAP METER FOR THE STUDY OF NUCLEAR EMULSION TRACKS. M.Dellagi.
J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 133A-137A (June, 1961). In French.
The simple apparatus described measures the total length L of gaps as a function of particle range R. The plate moves with constant speed parallel to a fixed direction; the measure of a length becomes the measure of a time, which is carried out by a chronometer photographed at constant time intervals by cinephotography. From the series of negatives obtained, the curve of L as a function of R can be drawn. Applications for 10 pions and one K meson (range : 700 μ) is given. The probability that the average value of M_π/M_K lies in the interval 0.257-0.295 is 0.95 (expected value for M_π/M_K : 0.283). This apparatus can be used for tracks as short as 210 μ.

16638 AN IMPROVED INSTRUMENT FOR NUCLEAR EMU SION TRACK PHOTOMETRY. S.v.Friesen and B.Persson.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 348-5 (Sept., 1960).
A description is given of a semi-automatic photometer of precision.

NUCLEAR FIELD THEORY

16639 ON THE FERMION MASS PROBLEM IN THE γ^5 INVARIANT MODEL OF QUANTUM FIELD THEOR B.A.Arbuzov, A.N.Tavkhelidze and R.N.Faustov.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 345-7 (July 11, 1961). In Russian.
Nondivergent models involving systems of fermion fields in acting with a real vector field in the two-dimensional space-tin are treated. In analogy with superconductivity theory "compens tion equations" are derived and solved approximately. A "supe conducting" solution is obtained. It is hoped that this solution r flects the qualitative features of the exact solution of the proble [English translation in: Soviet Physics–Doklady (USA)]. F.H

16640 A PROBLEM OF ANALYTIC COMPLETION RELA TO THE JOST–LEHMANN–DYSON FORMULA. J.Bros, A.Messiah and R.Stora.
J. math. Phys. (USA), Vol. 2, No. 5, 639-51 (Sept.-Oct., 1961).
Considers functions of a complex four-vector Q which are analytic in the domain formed by: (a) The future tube: ImQ in th future light-cone. (b) The past tube: ImQ in the past light-cone. (c) A complex neighbourhood of a domain R of real Q space limi by two space-like surfaces. It is shown, by using techniques pertaining to the theory of analytic functions of several comple variables, that all such functions can be analytically continued larger domain which coincides with the one predicted by the Jo Lehmann–Dyson formula.

16641 ROLE OF THE ASYMPTOTIC CONDITION IN A LAGRANGIAN FIELD THEORY. M.Wellner and R.B.Curtis.
J. math. Phys. (USA), Vol. 2, No. 5, 651-5 (Sept.-Oct., 1961).
The scattering operator of Feynman and Dyson for a self- interacting neutral scalar field is derived from a Lagrangian w the use of a canonical transformation between the Heisenberg a interaction pictures.

16642 ON THE ANALYTIC PROPERTIES OF THE 4-POIN FUNCTION IN PERTURBATION THEORY. A.Chi-Tai Wu.
K. Danske Vidensk. Selsk. mat.-fys. Medd. (Denmark), Vol. 33, 88 pp. (1961).
The analytic properties of the 4-point function as a functio 6 complex invariants are studied in simplest perturbation theo examples. This is a generalization of the work by Källén and Wightman (see Abstr. 32 of 1959) on the vertex function. The s ularity manifolds are: one 4-point singularity manifold, 4 sets the 3-point manifolds of the type discussed by Källén and Wight and 6 cuts. These are determined in three different ways, incl an explicit evaluation of the 4-fold Feynman parameter integra which results in a sum of 192 Spence functions. It is shown fro existence of the non-trivial geometric envelopes that the regula domain D_1^{pert} is in general not entirely bounded by the analytic surfaces. The boundary of the domain is illustrated with the a the 1-mass surfaces in some typical configurations of the 6 co variables, showing that the 4-point boundary will in general ca out bubble singularities from the 3-point boundary. It is hoped the results here may give some insight into the problem of find the envelope of holomorphy of the 4-point domain determined b axioms of the local field theory alone.

16643 TWO-POINT FUNCTION AND GENERALIZED FRE FIELDS. A.L.Licht and J.S.Toll.
Nuovo Cimento (Italy), Vol. 21, No. 2, 346-51 (July 16, 1961).
Several theorems are proven which relate to the possibil of constructing a noninteracting field with an arbitrary two-poi Wightman function. They are: (a) if $\varphi(x)$ is a complete local f and $[\varphi(x), \varphi(y)] = D(x-y)$, where D is an arbitrary operator.

ling on x and y only through their difference, then D is a ber function; (b) such fields are generalized free fields, as d by Greenberg; (c) any generalized free field is unitarily lent to a superposition of Klein–Gordon fields, and moreover ymptotic condition and unitarity restrict this to a superposition inary fields with different discrete masses.

16644 LINEAR VECTOR SPACES WITH INDEFINITE METRIC. L.K.Pandit.
Cimento Suppl. (Italy), Vol. 17, No. 1, 194-5 (1960).
See Abstr. 10575 of 1959. A mathematical error is corrected.

16645 ON A CONVERGENT MODEL OF QUANTUM FIELD THEORY WITH INDEFINITE METRIC. K.Yokoyama.
. theor. Phys. (Japan), Vol. 26, No. 1, 131-47 (July, 1961).
convergent model is proposed for the case of an indirect action between a physical neutral scalar field and a physical r field, by introducing four kinds of unphysical spinor fields play the roles of the intermediate states connecting these two cal fields. Two of these unphysical fields are set to have ive anticommutators and consequently the metric of the Hilbert becomes indefinite; nevertheless it is shown that the unitarity actual S-matrix holds strictly. Final results are such that vertex in the usual local theory is exactly replaced with some of extended vertex in this model which provides sufficient con- ency for all results. Although the extended vertex in this model nes singular at the two momentum values depending on the es of unphysical fields and the coupling constant, it is also n that there remains a considerable wide degree of freedom to ol the stable mass levels of the physical particles as suitably ssible.

16646 ANTICOMMUTATOR FOR THE FIELD CORRESPONDING TO SPIN $\frac{3}{2}$ IN AN EINSTEIN SPACE.
Schnerowicz.
C. Acad. Sci. (France), Vol. 253, No. 6, 940-2 (Aug. 7, 1961).
French.
The author's methods are extended to cover the case of spin $\frac{3}{2}$. The anticommutator reduces to that of Takahashi and Umezawa in the case of Minkowski space-time. R.A.Newing

16647 GAUGE-TRANSFORMATION AND QUANTIZATION OF FREE ELECTROMAGNETIC FIELD.
Pummer.
Acta phys. Austriaca, Vol. 14 No. 2, 149-53 (1961). In German.
It is shown that the difficulties arising from the vanishing rest of the photon during the quantization of Maxwell equations, can be avoided without introducing special artificial conditions. Covariant Lorentz expressions for field operators are obtained which are invariant under gauge transformations and which lead to gauge-invariant results in terms of gauge-invariant observables of the quantum electrodynamics. J.K.Skwirzynski

16648 CAUSALITY CONDITION AND NON-LOCAL LAGRANGIAN IN QUANTUM ELECTRODYNAMICS.
V.Shcherbina.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 93-5 (May 1, 1961).
In Russian.
For abstract, see Abstr. 13280 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 399-401 (Oct., 1961)].

16649 CORRECTIONS TO THE COULOMB INTERACTION IN NON-LOCAL ELECTRODYNAMICS. E.Arnous.
J. Phys. Radium (France), Vol. 22, No. 5, 326-7 (May, 1961).
In French.
A canonical transformation which eliminates longitudinal and scalar photons in non-local electrodynamics is given. The corresponding Coulomb interaction depends on the form factor and in general is modified at distances of the order of a (nucleon) Compton wavelength. T.Erber

16650 CLASSICAL THEORY OF RADIATION SOLUTIONS FOR THE COULOMB FIELD. P.A.Clavier.
Phys. Rev. (USA), Vol. 124, No. 2, 616-21 (Oct.15, 1961).
Eliezer has contended (Abstr. 32 of 1948) that the Dirac equations for the motion of a particle in a Coulomb field, when the radiation reaction is included, do not have physically realizable solutions. The problem is reinvestigated and Eliezer's conclusion proved false. Two-dimensional solutions (spirals) are found, which can be described with the exclusive use of integrable functions. One-dimensional solutions (radial trajectories) are found for both a repulsive and an attractive pole. The radial solutions involve distributions (in the sense of Schwartz). A consequence of the solutions is the emission of a strong pulse of radiation when a particle hits an attractive pole or when it leaves a repulsive one.

16651 ON THE DECOMPOSITION OF THE FEYNMAN PROPAGATOR.
A.Ramakrishnan, T.K.Radha and R.Thunga.
Proc. Indian Acad. Sci. A, Vol. 52, No. 5, 228-39 (Nov., 1960).
The Feynman propagator, in momentum representation, is a four-dimensional transform over space and time variables. If the space and time integrations are performed separately, the propagator can be decomposed into two parts, one corresponding to the positive and the other to the negative energy intermediate state. By the use of this decomposed proagator, the relative contributions of the positive and negative energy intermediate states to the matrix element can be estimated. For example in Compton scattering it leads to the apparently paradoxical result that in the "non-relativistic approximation" it is only the negative energy intermediate state that contributes to the matrix element.

16652 PHENOMENOLOGICAL QUANTUM ELECTRODYNAMICS IN THE CASE OF TWO MEDIA.
G.M.Garibyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1630-6 (Dec., 1960).
In Russian.
A macroscopic quantum electrodynamics of transition phenomena is constructed. The probabilities for the following first order processes are computed: transition and Cerenkov radiation, electron–positron pair conversion of photons incident on the boundary of the medium. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1138-42 (June, 1961)].

16653 THE USE OF AN ARBITRARY GAUGE OF THE ELECTROMAGNETIC POTENTIALS IN THE DISPERSION METHOD. V.D.Mur and V.D.Skarzhinskii..
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1076-9 (April, 1961).
In Russian.
The problem of the use of an arbitrary gauge of the electromagnetic potential of quantum electrodynamics within the framework of the dispersion method is considered. Several formulae are obtained which are generalizations of known expressions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 759-61 (Oct., 1961)].

16654 QUATERNION FORMULATION OF THE RELATIVISTIC ROTATING PARTICLE. F.Halbwachs.
C.R. Acad. Sci. (France), Vol. 252, No. 12, 1734-6 (March 20, 1961).
In French.
The relativistic rotating elementary particle is characterized at each instant by the Lorentz transformation which carries a fixed ennuple into one "fixed to the particle". Since it is well known that such transformations can be described by unimodular quaternions, the states are represented by points of the unit hypersphere in Euclidean 4-space. C.W.Kilmister

16655 QUANTIZATION OF THE MOTION OF THE RELATIVISTIC ROTATING PARTICLE. F.Halbwachs.
C.R. Acad. Sci. (France), Vol. 252, No. 13, 1907-9 (March 27, 1961).
In French.
The quaternion formulation of the relativistic rotating particle (see preceding abstract) is used to express the dynamical variables, which can then be quantized in the usual way. C.W.Kilmister

16656 ON THE ÚLEHLA-PETRÁŠ WAVE EQUATION.
J.Formánek.
Czech. J. Phys., Vol. 11, No. 8, 545-53 (1961).
The Petras (Abst. 1849 of 1956) and the Ulehla [Ulegla] (Abstr. 1809 of 1958; 2602 of 1959) relativistic wave equations for an anomalous electrically charged particle with spin one half are examined and their mutual relation as well as their connection with the usual Dirac-Pauli equation are clarified.

16657 ON A MODIFICATION OF WEYSSENHOFF'S HOMOGENEOUS VARIATIONAL PRINCIPLE WITH HIGHER DERIVATIVES. Z.Borelowski.
Acta phys. Polon. (Poland), Vol. 20, No. 8, 619-32 (1961).

Weyssenhoff (Abstr. 8652 of 1952) proposed a homogeneous variational principle with higher derivatives describing the motion of a free spin particle whose velocity can be both smaller than or equal to that of light. In the latter case, the Lagrangian of the particle is found to be a first integral of the equations of motion, provided the time t, measured in an inertial reference system Σ_0 where the spatial coordinates of the four-momentum of the particle vanish, is used as parameter. In the present paper, this principle is modified by introducing the postulate that the Lagrangian shall also be a first integral of the equations of motion in the case of the particle moving with velocity smaller than that of light. From the equations of motion thus obtained, equations resembling those of Mathisson (1934) for a free spin particle are then derived (however, Frenkel's condition cannot be fulfilled). According to these equations, the spin particle moves in the system Σ_0 with constant velocity v along a circle of constant radius R. The quantities v and R depend only on the spin of the particle, its rest mass and a constant l_0 of the dimension of length.

16658 THE BEHAVIOUR OF THE SPIN OF DIRAC PARTICLES IN COLLISION PROCESSES. A.A.Sokolow.
Ann. Phys. (Germany), Vol. 8, No. 5-6, 237-59 (1961). In German.

A fundamental paper on spin and parity questions summarizing much of the recent work of the Russian school. The spin four-vector is introduced through a specialization of the angular momentum tensor; the spin three-vector is then identified from a special case. Commutation and transformation properties are treated in considerable detail. Spin and "spirality" (chirality) are linked in a discussion of the physical interpretation. It is shown that the conservation of spirality (in the ultra-relativistic limit) automatically singles out the V and A interactions. Considerable attention is given to the problem of space inversion for particles with spin; it is claimed that two distinct space reflections are required. The chirality arguments of Landau, Yang, and Lee are challenged. Polarization and parity effects in purely electromagnetic interactions are also cited: examples include polarized synchrotron radiation; spirality conservation in high energy bremsstrahlung; and modifications in Compton scattering. T.Erber

16659 WAVE EQUATIONS FOR SCALAR AND VECTOR PARTICLES IN GRAVITATIONAL FIELDS. S.Hjalmars.
J. math. Phys. (USA), Vol. 2, No. 5, 663-7 (Sept.-Oct., 1961).

An earlier representation of the Kemmer wave equation in Riemann space is modified so as to remove the matrices, which in general have to be added to the differential operators of the equation. It is pointed out that the possibility of this removal is equivalent to the fact, known from Maxwell's equations, that if only scalars, vectors, and antisymmetrical tensors are involved, the field equations can be written with ordinary derivatives without explicit use of the affine connection. The wave equation is written in component form, and the photon zero mass case is obtained by means of the most general matrix mass term, without any questionable limiting process.

16660 CANONICAL TRANSFORMATIONS OF DIRAC'S EQUATION TO EVEN FORMS. EXPANSION IN TERMS OF THE EXTERNAL FIELDS. E.Eriksen and M.Kolsrud.
Nuovo Cimento Suppl. (Italy), Vol. 18, No. 1, 1-39 (1960).

The ideas of Abstr. 2071 of 1959 are extended so that the transformed Hamiltonians, as well as being even and energy-separating, can be simply expanded in powers of the coupling constant with the external field. This is done both by finding closed forms (based on square roots of unitary operators), and by iteration methods like the Foldy—Wouthuysen transformation; the transformations are first applied in the time-independent case, then generalized to the time-dependent case. Charge distributions of the fermion in the new representations are discussed. J.Hawgood

16661 ON THE RELATIONS BETWEEN CHARGES AND SPIN. F.Lurçat and L.Michel.
Nuovo Cimento (Italy), Vol. 21, No. 3, 574-6 (Aug. 1, 1961).
In French.

The following formula relating the electric charge, q, the baryonic charge, b, and the leptonic charge, l, to the angular momentum, j, of a physical state is obtained from general axio concerning the Hilbert space:

$$(-1)^{2j} = (-1)^{\epsilon_q q + \epsilon_b b + \epsilon_l l}$$

where the ϵ's equal 0 or 1. Experiments give a law of this for with $\epsilon_q = 0$, $\epsilon_b = \epsilon_l = 1$. T.

16662 AN INTERPRETATION OF THE ISOBARIC SPIN SPACE. T.A.J.Maris.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 46-51 (Sept., 1961).

It is shown that the group of isobaric spin rotations is homomorphous with a certain group of Lorentz-invariant trans formations of a 4-component spinor field. It seems possible t give a simple interpretation of the isobaric spin operators of int acting fields, known from the Dirac theory.

16663 INTERPRETATION OF ISOBARIC MULTIPLETS I TERMS OF THE SPACE—TIME REFLECTION GROUP. H.Sokolik.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 94-102 (Sept., 1961).

Deals with a mathematical interpretation of Goldanski's scheme (Abstr. 5169 of 1958). The number of spinor and scala representations of the general Lorentz group is shown to be equal to the total number of mesons and baryons of the Gell-M scheme.

16664 FURTHER RESULTS ON THE WAVE THEORY OF ELECTRONS, PHOTONS AND OTHER ELEMENTA PARTICLES. J.Picht.
Optik (Germany), Vol. 17, No. 9-10, 567-75 (Sept.-Oct., 1960).
In German.

The phase-characteristic equations of the motion of a mat particle are determined in consequence of the Hamilton princi least action. The "breathing" (pulsating) particle is treated; t oscillating field of the stationary electron (elementary part- icle) and the wave resulting from the particle when moved with stant velocity, and their surfaces of constant amplitude are co sidered. The "gravitational wave" of the particle in motion, it electromagnetic (characteristic) field wave, and the wave equa of the electron in motion outside and "inside" the particle are The inhomogeneous wave is described, a doubly infinite numbe inhomogeneous plane waves or a singly infinite number of head The relativistic apparent absorption of space relative to the w propagation is finally considered.

16665 DYNAMICAL MODEL OF ELEMENTARY PARTIC BASED ON AN ANALOGY WITH SUPER-CONDUCTIVITY. II. Y.Nambu and G.Jona-Lasinio.
Phys. Rev. (USA), Vol. 124, No. 1, 246-54 (Oct. 1, 1961).

Continuing the programme developed in Pt I (Abstr. 7193 1961), a "superconductive" solution describing the proton—neu doublet is obtained from a nonlinear spinor field Lagrangian. authors find the pions of finite mass as nucleon—antinucleon b states by introducing a small bare mass into the Lagrangian w otherwise possesses a certain type of the γ_5 invariance. In addition, heavier mesons and two-nucleon bound states are obt in the same approximation. On the basis of numerical mass relations, it is suggested that the bare nucleon field is similar the electron—neutrino field, and further speculations are made concerning the complete description of the baryons and leptons

16666 LAGRANGIAN FORMALISM FOR A CLASSICAL R LATIVISTIC PARTICLE ENDOWED WITH INTERN STRUCTURE. F.Halbwachs.
Progr. theor. Phys. (Japan), Vol. 24, No. 2, 291-307 (Aug., 196

Variational methods are used to develop a purely classica theory of a generalized particle whose internal state is descri in terms of a set of 4-vector variables. Generalized Frenkel- Weyssenhoff equations are derived and applications are made case of a relativistic spinning particle moving in an electroma field. R.A.M

16667 ON MASS FORMULA AND NEW IMAGE OF ELEMENTARY PARTICLES. A.Ohmae.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 910-12 (Oct., 1960

The total c.m. energies at which resonances in high energ π—p cross-sections occur are given by the rule,

$$E = R_N[1/4^2 - 1/(4 + m)^2],$$

with m = 1,2,..., R_N = 36-37 BeV. Similar rule holds for the r

ses of the elementary particles:

$$M = R_K[1/8^2 - 1/(8 + m)^2] ,$$

= 150 BeV. In analogy to Rydberg's constant, we can therefore $R_N = 2\pi^2 M g^4/h^3 c$, $M \cong 500\ m_e$, g = strong-coupling constant of ps theory. This suggests a composite model of the elementary icles with strongly bound constituent elements. Vachaspati

16668 ON THE NEW CONSTANT AND THE STRANGENESS. A.Ohmae.
gr. theor. Phys. (Japan), Vol. 24, No. 4, 913-15 (Oct., 1960).
The mass formula given in a previous paper (see preceding ract) is refined. The masses of the elementary particles ier than muon and the total energies where resonances in and K^-–p scattering cross-sections occur are written as

$$M = R_N[1/(n + \tfrac{1}{2}s' + \delta')^2 - 1/(m + l + \tfrac{1}{2}s + \delta)^2] ,$$

re n and m are mass quantum numbers, l is internal azimuthal ntum number, s and s' are strangeness spin quantum numbers, δ and δ' are corrections. Estimates of δ and δ' are given. Vachaspati

16669 REMARKS ON THE MASS FORMULA IN THE SAKATA MODEL. K.Matumoto.
gr. theor. Phys. (Japan), Vol. 25, No. 6, 1047-9 (June, 1961).
Reports that the coefficients in the mass formula were determined fitting empirical values and that the results con- ned the assumptions in previous work. It is shown that the mass nula can be put in a form such that the main part of it is due he baryonic charge and involves a constant only. The signifi- ce of these results is discussed. F.Herbut

16670 OBSERVABLES IN THE EXTREME RELATIVISTIC REPRESENTATION OF THE DIRAC EQUATION. .Mathews and A.Sankaranarayanan.
g. theor. Phys. (Japan), Vol. 26, No. 1, 1-6 (July, 1961).
A new choice of operators is given to represent dynamical iables of a Dirac particle in the extreme relativistic represent- on.

16671 THE THEORY OF "STRANGE" PARTICLES. H.P.Durr and W.Heisenberg.
Naturforsch. (Germany), Vol. 16a, No. 8, 726-47 (Aug., 1961).
German.
Strange particles can be represented within the framework of linear spinor theory by taking into account the degeneracy with spect to isospin and parity of the groundstate "vacuum". Use is de of the mathematical analogy between superconductivity theory l elementary particle theory, and to a first approximation a rfold degeneracy of the groundstate is assumed. Each of the r states is treated as a mixture of states of similar symmetry. een functions of the type $\langle \Omega_\alpha | T X(x) \bar{X}(x') | \Omega_\beta \rangle$ are treated as ariant under the proper Lorentz group, CPT and PG, when plied to the field operators or the states $\Omega_\alpha\rangle$ separately; but invariant under isospin rotation, P or CT or G, only if the nsformation is applied to the field-operators and the states $\Omega_\alpha\rangle$ nultaneously. Only stationary states of strangeness 1 can be nsidered in this approximation. The fourfold degeneracy of the meson is reduced to an additional symmetry which may be nnected later to the existence of electromagnetic charge. The sults of the calculations may be interpreted by describing the range particles as composed of ordinary particles and a "spurion" en from the goundstate "vacuum". The "spurion" carries an spin $\frac{1}{2}$ and a parity. The mass-eigenvalues and the parity of the rticles are calculated by a slightly improved version of the mm–Dancoff method. The theoretical mass-eigenvalues agree alitatively with the observed masses. The calculated relative rities of the strange particles may later be checked by experi- nt. Besides the known particles of strangeness 1, the theory lds other eigenstates which are probably highly unstable, since y could disintegrate into more stable particles by means of ong or electromagnetic interactions.

16672 UNSTABLE PARTICLE IN THE LEE MODEL. Ya.B.Zel'dovich.
. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1155-9 (April, 1961).
Russian.
An unstable particle is considered which can decay according $V \to N + \theta$ in the Lee model (Abstr. 9936 of 1954) of a non-relativistic second-quantized theory. Perturbation theory for an eigenstate expansion of any initial state is generalized to the case of an unstable particle. A quantity playing the role of the norm of the state of such a particle is defined. A new method is given for finding the amount of time a stable V' particle, which can undergo virtual transitions to the $N + \theta$ state, spends in each of its two possible states. This method is then applied to an unstable V particle, and a definite value is obtained for the amount of time it spends in each state; however, this value is found to be complex. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 4, 813-15 (Oct., 1961)].

16673 "SCALAR" FORM OF THE DIRAC EQUATION AND CALCULATION OF THE MATRIX ELEMENTS FOR REACTIONS WITH POLARIZED DIRAC PARTICLES. Yu.D.Usachev.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 400-9 (Aug., 1961).
In Russian.
A formalism first proposed by Sommerfeld is developed in which the wave-function in the Dirac equation is a scalar and the corresponding γ-matrices behave as 4-vectors under Lorentz transformations. The transition to the indicated representation and its features are investigated. The solutions of the equations thus derived are determined and the spin operator of the "scalar" Dirac equation, which turns out to be differential, is investigated. A new method for calculating the matrix elements of reactions involving polarized particles is indicated. For this purpose a method of expressing the γ-matrices in terms of the Kronecker δ-symbols and of some discontinuous functions is also suggested. [English translation in: Soviet Physics–JETP (USA)].

16674 ON THE THEORY OF THE VECTON. I.Yu.Kobzarev and L.B.Okun'.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 499-506 (Aug., 1961).
In Russian.
Consequences of the hypothesis that strong coupling is the result of the interaction between a neutral vector particle (the vecton) and a baryon current are considered. The appearance in such a model of isotopic invariance and in particular of a π-meson triplet is also considered. Experimental possibilities of detecting the vecton are examined in detail. [English translation in: Soviet Physics–JETP (USA)].

TEST OF CHARGE-CONJUGATION INVARIANCE IN STRONG INTERACTIONS. See Abstr. 16788

16675 SOME TOPOLOGICAL PROPERTIES OF FEYNMAN DIAGRAMS. W.Garczyński.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 6, 473-6 (1961).
The author demonstrates some properties of Feynman diagram matrices, using the method of Bogolyubov and Parasiuk [Izvestiya Akademii Nauk SSSR, Seriya matemicheskiya, Vol. 20, 585 (1956) and Acta Mathematiça (Sweden), 97, 227 (1957)]. C.Wilkin

16676 ON THE ANGULAR MOMENTUM WEIGHT FACTOR IN THE STATISTICAL THEORY OF MULTIPLE PARTICLE PRODUCTION. Z.Koba.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 211-16 (1961).
In a previous paper (Abstr. 7199 of 1961) the author proposed a new formulation of the statistical theory of multiple particle production in which the angular momentum of the system is strictly conserved. This note describes the general properties, methods of evaluation and a recurrence formula of the angular momentum weight factor $Z_n(l_1, l_2 \ldots l_n)$ which plays and essential role in the above theory and which is defined by

$$D^{(l_1)} \times D^{(l_2)} \times \ldots \times D^{(l_n)} = \sum_\lambda Z_n(l_1 \ldots l_{n-1}, \lambda)\, D^{(\lambda)},$$

where $D^{(m)}$ denotes the (2m + 1)-dimensional irreducible representation of the three-dimensional rotation group. C.Wilkin

16677 ON SYMMETRIES SHARED BY STRONG AND WEAK INTERACTIONS. A.Pais.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 493-7 (July, 1961).
Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Discusses how the parity properties of weak nonleptonic processes illuminate the symmetries of strong interactions. Develops an application of the

doublet symmetry to hyperon decays, on this basis (see Abstr. 7285 of 1961). R.J.N.Phillips

16678 A UNIFIED DYNAMICAL APPROACH TO HIGH AND LOW-ENERGY STRONG INTERACTIONS. G.F.Chew.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 467-70 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Describes an approximation, designed for all energies but small momentum transfer, in which the two-dimensional Mandelstam spectral functions are retained only in certain strips near the physical region. Conjectures that strong interactions may be "as strong as possible" subject to the unitarity and analyticity of the S-matrix.
R.J.N.Phillips

16679 SOME REMARKS ON SAKURAI'S THEORY OF STRONG INTERACTIONS. A.P.Balachandran and N.G.Deshpande.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1022-3 (June 1, 1961).

It is pointed out that in Sakurai's theory (Abstr. 3126 of 1961) it is necessary to consider all the baryon or spinless meson fields as compound in order not to forbid certain processes. J.E.Paton

16680 BOUND-STATE MODEL OF WEAK AND STRONG INTERACTIONS.
C.H.Albright, R.Blankenbecler and M.L.Goldberger.
Phys. Rev. (USA), Vol. 124, No. 2, 624 et seq. (Oct. 15, 1961).

The pion—nucleon coupling constant is calculated from first principles by use of the N/D matrix method. Three models are introduced which contain pions, nucleons, and weakly interacting intermediate bosons of the scalar, pseudoscalar, and vector variety. The basic interactions are taken to be parity and isotopic-spin conserving. Certain physical assumptions in the nature of boundary conditions and the known fact that the weak coupling is very weak, together with use of the Born approximation for N, enables an eigenvalue equation to be obtained which expresses the pion—nucleon coupling constant in terms of the three masses in the problem. The correct value for g_π^2 can be obtained for an intermediate vector meson of mass comparable to the nucleon mass with essentially no cutoff employed; on the other hand, the experimental value is also obtained with a spin-zero boson and a relatively small cutoff energy.

16681 SOME REMARKS ON THE STRUCTURE OF ELEMENTARY PARTICLE INTERACTIONS.
A.Ramakrishnan, A.P.Balachandran and N.R.Ranganathan.
Proc. Indian Acad. Sci. A, Vol. 53, No. 1, 1-11 (Jan., 1961).

The existence of symmetries which can lead to minimal electromagnetic interactions are investigated and three specific invariances to obtain this minimal character proposed. Applications of these principles to strong and weak interactions are seen to lead to certain useful results. A model of strong interactions arising out of these considerations is also discussed.

16682 WEAK INTERACTIONS AT HIGH ENERGIES.
K.Fujii, H.Nagai, T.Sakuma and T.Tsuchida.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 849-51 (May, 1961).

An estimate is made of the μ meson production in high energy nucleon—nucleon collisions using the peripheral interaction model.
J.H.Gunn

16683 SOME SPECULATIONS ON THE NEW RESONANCES.
A.Salam.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 426-30 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Discusses the theoretical significance of recently reported resonances in the $\pi + Y$, $\pi + K$ and $\pi + \pi$ systems. Describes various conjectures, including a gauge theory of elementary particles.
R.J.N.Phillips

16684 PERIPHERAL CONTRIBUTIONS TO HIGH-ENERGY INTERACTION PROCESSES. S.D.Drell.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 458-66 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Explains the importance of one-meson exchange processes in high-energy interactions with low momentum transfer. Reviews applications of this concept: to determine coupling-constants and scattering from unstable targets, to relate different experimental quantities, and to show how to produce well-defined beams of secondary particles.
R.J.N.Phillips

16685 RECOIL EFFECT FOR THE TWO PARTICLE INTERACTION IN NONRELATIVISTIC QUANTUM FIELD THEORY. A.V.Tulub.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 488-90 (Feb., 196
In Russian.

The effect of the recoil on the two-particle interaction ener is considered for the case of a scalar field theory. [English tra lation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 341-2 (Aug., 1961)].

16686 THEORY OF FERMION MASSES.
Ya.B.Zel'dovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 637-40 (Feb., 196
In Russian.

It is shown that the four-fermion interaction to any order w not yield masses for particles that have no bare mass. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 444 (Aug., 1961)].

16687 THE MAXIMUM CHARGE FOR GIVEN MASS OF A BOUND STATE.
V.N.Gribov, Ya.B.Zel'dovich and A.M.Perelomov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1190-8 (April, 196
In Russian.

Using dispersion relations, an elementary derivation is give of the inequality restricting the charge, which was found by Ruderman and Gasiorowicz (Abstr. 6634 of 1958). The maximu charge corresponds to the authors' notion of a composite partic A field-theoretic nonrelativistic model is treated; it is shown that the physical (renormalized) charge tends to its maximum value when the bare charge increases without limit (for a fixed m of the particle). The scattering then corresponds to the theory o the deuteron. In this same model, with an unstable particle, as charge increases without limit the scattering tends toward zero. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 836-41 (Oct., 1961)].

16688 FERMI SYSTEMS WITH ATTRACTIVE AND REPUL INTERACTIONS. M.Ya.Amus'ya.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 429-40 (Aug., 19
In Russian.

A homogeneous space-infinite system of Fermi particles wi pair interaction is investigated by quantum field theory methods The interaction consists of two parts: an attraction U with a ra and a strong repulsion V with a range a, where $b \gg a$. For an in mediate density $\rho(b^3\rho > 1$ and $a^3\rho < 1)$ the expression for the gr state energy is expanded over two parameters $a\rho^{1/3}$ and $1/b\rho^{1/3}$. graphs are taken into account whose contributions to the energy not smaller than the contribution of the gas approximation term which is cubic with respect to a. The conditions are determined which the system states are such that $E_{cp} < 0$, $\partial E_{cp}/\partial\rho = 0$, $\partial^2 E_{cp}/\partial\rho^2 > 0$ (E_{cp} is the energy per particle). An equation set is derived in a two-parameter approximation which yields the energy of the ground state. The equation set derived in the pres paper is compared with the Brueckner equation set correspondi the gas approximation (Abstr. 2515 of 1958). [English translatio in: Soviet Physics—JETP (USA)].

DISPERSION RELATIONS FOR COMPTON EFFECT IN NUCLEONS. See Abstr. 16729

16689 DISPERSION RELATIONS IN NON-LOCAL FIELD THEORY. V.D.Sutula.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 1, 100-2 (Sept. 1, 1961).
In Russian.

Using the condition of macrocausality obtained previously (Abstr. 5627 of 1961) the author investigates the question of the construction of dispersion relations in a non-local field theory. The author comes to the conclusion that even if the generalizati to a non-local theory is impossible, there is an "elementary len over which ordinary dispersion relations should hold. [English translation in: Soviet Physics—Doklady (USA)]. C.W

16690 RENORMALIZATION OF TIME-ORDERED GREEN' FUNCTIONS. K.Nishijima.
Phys. Rev. (USA), Vol. 124, No. 1, 255-63 (Oct. 1, 1961).

The renormalization of time-ordered Green's functions is carried out without reference to Feynman diagrams. The argu- ments are entirely based on the generalized unitarity condition

th arametric dispersion relations. The renormalization of the m n–nucleon interaction is studied, and then a close examination is ven of the renormalization of quantum electrodynamics in a sp al gauge. Finally the connection between the subtraction c ants in dispersion relations and renormalization constants is cl fied in a simple model.

16691 AN EXAMPLE OF A SCATTERING SYSTEM IN JAUCH'S SENSE. S.T.Kuroda.
F r.theor. Phys. (Japan), Vol. 24, No. 2, 461-2 (Aug., 1960).
It is pointed out that the model proposed in Abstr. 4945 of 1 represents a "scattering system" as defined by Jauch (Abstr. 6 of 1959). P.K.Kabir

16692 ASYMPTOTIC BEHAVIOUR OF THE SCATTERING AMPLITUDE AT INFINITE ENERGIES. L.A.Khalfin.
Z eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 493-7 (Feb., 1961). Russian.
Investigated on the basis of the unitarity condition. A relation b een the asymptotic form of the forward scattering amplitude a the derivatives of the differential cross-sections for elastic s tering with respect to the angle is established. [English t slation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 345-8 ., 1961)].

16693 THE VIRIAL THEOREM FOR THE CLASSICAL PROBLEM OF THE SCATTERING OF A PARTICLE BY ENTRE OF FORCE. Yu.N.Demkov.
l. Akad. Nauk SSSR, Vol. 138, No. 1, 86-9 (May 1, 1961). Russian.
For abstract, see Abstr. 15695 of 1961. [English translation Soviet Physics—Doklady (USA), Vol. 6, No. 5, 393-5 t., 1961)].

VARIATIONAL METHOD FOR SCATTERING LENGTH. Abstr. 15700

16694 ON SOME REPRESENTATION OF PERTURBATION EXPANSION OF SCATTERING AMPLITUDE. Jarczyński.
l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, 6, 467-71 (1961).
An expression for the contribution of a connected Feynman gram. G, to the collision amplitude is derived. In the case n $\omega(G) = 4C_L - 2L \geq 0$ (where L is the number of internal lines C_L denotes the number of closed loops in the diagram) ularization is carried out. For $\omega(G) < 0$ the expression is shown be equivalent to the Chisholm formulae. F.Herbut

16695 NEW TYPES OF INTERACTION IN THE NON-LOCAL THEORY OF THE MESON FIELD. E.Arnous.
Phys. Radium (France), Vol. 21, No. 11, 807-8 (Nov., 1960). French.
It is pointed out that a number of experimental facts seem to licate that there is a cut-off in the interactions close to the cleonic mass. Suitable form factors and interaction Hamiltonians owing for this effect are discussed. F.Herbut

16696 ACNODES AND CUSPS ON LANDAU CURVES. R.J.Eden, P.V.Landshoff, J.C. Polkinghorne and C.Taylor.
math. Phys. (USA), Vol. 2, No. 5, 656-63 (Sept.-Oct., 1961).
It is shown that the Landau curve for a reduced sixth-order agram can acquire acnodes and real cusps as the masses are ried. They are associated with complex singularities that under rtain conditions are in the physical sheet and cause a breakdown the Mandelstam representation. The problem of obtaining general iteria for acnodes and cusps is discussed.

16697 SOME REMARKS ON HIGH-ENERGY INELASTIC COLLISIONS WITH SMALL MOMENTUM TRANSFER. Beckmann.
uovo Cimento (Italy), Vol. 20, No. 4, 812-13 (May 16, 1961).
Considers the process A + B → A + B + C for low momentum ansfer and compares the contributions to this cross-section from process in which A emits a virtual C particle which is elastically attered off B and a process in which B is elastically scattered f A and subsequently decays into B and C. C.Wilkin

16698 A NATURAL BOUNDARY OF THE SCATTERING AMPLITUDE ON AN UNPHYSICAL SHEET. P.G.O.Freund and R.Karplus.
Nuovo Cimento (Italy), Vol. 21, No. 3, 519-23 (Aug. 1, 1961).
The scattering amplitude has a two-sheeted branch point at zero kinetic energy. It is shown that the amplitude on the second (unphysical) sheet has a natural boundary that terminates at zero total energy.

16699 ON A MATHEMATICAL PROBLEM ENCOUNTERED IN QUANTUM FIELD THEORY. R.Omnès.
Nuovo Cimento (Italy), Vol. 21, No. 3, 524-30 (Aug. 1, 1961).
The problem of determining a unitary analytic function whose discontinuity on a cut is known is reduced to the solution of a Fredholm equation. This method leads to much simpler and physically transparent results than the N/D method by Chew and Mandelstam (Abstr. 13019 of 1960). The connection between the two methods is elucidated. The ambiguity in the solution is completely displayed. The resulting form gives insight in the structure of the s* matrix under an inelastic threshold.

16700 ANOMALOUS THRESHOLDS OF REACTION AMPLITUDES. P.G.O.Freund and R.Karplus.
Nuovo Cimento (Italy), Vol. 21, No. 3, 531-40 (Aug. 1, 1961).
Anomalous thresholds of reaction amplitudes are studied without recourse to a partial wave expansion. It is shown that the behaviour of the amplitudes is quite similar to that of the partial wave projections even though the Legendre series does not converge near the anomalous threshold.

16701 REMARK ON THE RADIOACTIVE MUON DECAY IN THE THEORY WITH AN INTERMEDIATE VECTOR MESON. Z.Bialynicka-Birula.
Nuovo Cimento (Italy), Vol. 21, No. 3, 571-3 (Aug. 1, 1961).
There is great difficulty in explaining the lack of radioactive muon decay in a theory with an intermediate charged vector meson. The usual theory with an intermediate meson is non-renormalizable and therefore required a cut-off to be introduced. By using a different Lagrangian, the author tests, without success, an alternative possibility of introducing the charged vector meson into the theory of weak interactions. J.H.Gunn

16702 POTENTIAL SCATTERING AS OPPOSED TO SCATTERING ASSOCIATED WITH INDEPENDENT PARTICLES IN THE S-MATRIX THEORY OF STRONG INTERACTIONS. G.F.Chew and S.C.Frautschi.
Phys. Rev. (USA), Vol. 124, No. 1, 264-8 (Oct. 1, 1961).
A definition of a relativistic generalized potential is given, suitable at arbitrary energies for a pair of particles whose elastic scattering amplitude satisfies the Mandelstam representation. It is shown that the generalized potential plays a role in the dynamics analogous to that of the ordinary nonrelativistic potential in a Schrödinger equation and determines the scattering to the same extent. Below the threshold for inelastic processes the generalized potential is real and its energy dependence in the elastic region is expected for certain particle combinations (such as the nucleon–nucleon) to be weak. In such cases one may uniquely define, for use in the Schrödinger equation, an energy-independent ordinary potential that coincides with the potential of Charap and Fubini (Abstr. 1252 of 1960). In general, when the potential is complex and energy-dependent the dynamical problem involves iteration of an integral equation deduced by Mandelstam (Abstr. 4941 of 1959). The generalized potential may be decomposed according to range and it is shown that keeping only the long- and medium-range parts, corresponding to transfer of one or two particles, is almost equivalent to the "strip approximation." Finally, a general definition is given of "pure potential scattering" as opposed to scattering associated with "independent" particles, either stable or unstable, and a variety of experimental situations are discussed with respect to this distinction, which is shown to be susceptible to experimental test.

16703 TWO PICTURES OF THE STRONG-COUPLING METHOD. H.Jahn.
Phys. Rev. (USA), Vol. 124, No. 1, 280 et seq. (Oct.1, 1961).
In the strong-coupling method of the meson theory two different pictures have been used. One picture exhibits the isobaric nature of the meson–nucleon interaction by expressing the Hamiltonian in terms of the integrals of motion of the total system. It may be called the rotation picture. In the other picture the isobaric depend-

ency comes out by splitting the total system into a free field system and a compound nucleon system, such that the interaction between them vanishes for infinite g. It may be called the splitting picture. These two pictures are compared. The difference between them with regard to the scheme of the strong-coupling approximation method, especially with regard to the calculations of isobaric energy corrections and resonance scattering, is investigated.

16704 ON THE INTERACTION IN NUCLEON CORE. S.Minami.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 216-18 (July, 1960).

The suggestion (Abstr. 3219 of 1961), that the value of the coupling constant is diminished in effect by a factor $\mu/2M$ within the nucleon core as compared to its value at greater distances, is discussed in terms of field theory. P.K.Kabir

16705 S-WAVE PION—NUCLEON PHASE SHIFTS. K.Ishida.
Prog. theor. Phys. (Japan), Vol. 24, No. 2, 459-60 (Aug., 1960).

It is shown that the expression obtained from dispersion relations (Abstr. 7428 of 9157) for the quantity $\alpha_1 - \alpha_3$, in agreement with experiments, may be interpreted as the result of the change in the effective S-wave coupling constant due to the P-wave cloud surrounding the nucleon core. The formula for $\alpha_1 + 2\alpha_3$ does not admit of such a simple interpretation. P.K.Kabir

16706 MOVING EFFECT OF NUCLEON TO MESON FIELD. T.Sasakawa.
Progr. theor. Phys. (Japan), Vol. 24, No. 4, 917-18 (Oct., 1960).

The importance of taking nuclear motion into account when determining the pion—nucleon coupling constant from the analysis of nuclear force data is pointed out. It is shown on a simple classical model that the modified coupling constant may exceed the static coupling constant by 10%. The effect becomes more significant with increasing energy. Vachaspati

16707 MASS OF A NEUTRAL VECTOR MESON AND p—p SCATTERING. S.Ohnuma.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 847-9 (May, 1961).

High energy p—p scattering strongly indicates the existence of a spin—orbit interaction between two nucleons. Since pion-theoretical calculations fail to give a sufficiently large spin—orbit term, Sakurai assumed the existence of a hitherto unobserved neutral vector meson of mass 3 or 4 pion masses. The author claims that Sakurai's calculation of Wolfenstein's amplitude C for p—p scattering does not have the right energy dependence at a p—p scattering angle of 90° if the mass of the neutral vector meson is fixed by the angular dependence of C. J.H.Gunn

16708 NOTE ON THE INTEGRAL REPRESENTATION OF ABSORPTIVE PART OF VERTEX FUNCTION. K.Yamamoto.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1056-7 (June, 1961).

An incorrect conclusion concerning Jost's example (Abstr. 10611 of 1959) is rectified. F.Herbut

16709 ANOMALOUS THRESHOLDS. R.E.Cutkosky.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 448-54 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Discusses the physical meaning of anomalous thresholds in S-matrix elements, and shows how they appear naturally in unstable particle scattering. Describes the properties of singularities deduced from perturbation theory, and the possibility of a complete dynamical S-matrix theory. Illustrates, with a modified Bethe—Salpeter equation, how dispersion relations determine dynamical behaviour. R.J.N.Phillips

16710 PROPERTIES OF THE SCATTERING AMPLITUDE RESULTING FROM THE UNITARITY CONDITION. M.A.Braun and L.V.Prokhorov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1641-6 (Dec., 1960). In Russian.

The restrictions imposed on the two-particle scattering amplitude by the unitarity condition are investigated. It is shown that (1) the imaginary part of the scattering amplitude is a bounded function of the energy and possessses no discontinuities of the first kind in the physical region of the variables; (2) as the energy tends to infinity the amplitude cannot grow without bound, except possibly for some particular values of the scattering an (3) under certain reasonable assumptions the total scattering cross-section cannot grow indefinitely with increasing energy. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1146-9 (June, 1961)].

16711 LOW ENERGY INTEGRAL EQUATION FOR $\pi-\pi$ SCATTERING. Syan' Din-Chan [Hsien Ting-Ch'ang], Khé' Tszo-Syu [Ho Tso-H and V.Tsëllner.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1668-76 (Dec., 19 In Russian.

A critical analysis of the Chew—Mandelstam equations for $\pi-\pi$ scattering is presented. With the help of fixed momentum transfer dispersion relations and the unitarity condition new equations are derived, which are entirely different from the Chew—Mandelstam equations as far as the contribution from th unphysical region is concerned. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1165-70 (June, 1961)].

16712 APPLICATION OF THE MANDELSTAM METHOD TO THE COMPUTATION OF SCATTERING AMPLI WITH ANOMALOUS SINGULARITIES. V.A.Franke.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1812-28 (Dec., 19 In Russian.

Mandelstam's method for the calculation of the scattering amplitude (Abstr. 4941 of 1959) is extended to the case of two i acting neutral scalar fields describing particles with masses m M subject to the condition $m\sqrt{3} > M > m\sqrt{2}$. The anomalous singularities of the amplitude which appear as a consequence of indicated relation between the masses are taken into account. conditions for the extension of the method of the present paper to complicated cases are indicated. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1269-76 (June, 1961)].

16713 THE THREE-BODY PROBLEM WITH SHORT-RANG FORCES. G.S.Danilov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 498-507 (Feb., 19 In Russian.

It is shown that the scattering amplitude for the scattering a particle on the bound state of two other particles can be expre in terms of the parameters of the two-particle problem and the energy of the bound state of the three particles. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 349-55 (Aug., 1961)].

16714 SYMMETRY OF THE SOLUTIONS OBTAINED IN DETERMINING THE SINGULARITIES OF FEYNMA DIAGRAMS BY LANDAU'S METHOD. A.Z.Patashinskii.
Zh. eksper. teor. Fiz. (USSR) Vol. 39, No. 6, 1744-6 (Dec., 196 In Russian.

It is proved that for some diagrams the solutions obtained b Landau's method for determining the position of the singularitie are symmetric. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1217-18 (June, 1961)].

16715 POSITIONS OF THE SINGULARITIES OF CERTAIN FEYNMAN DIAGRAMS. V.A.Kolkunov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 678-83 (Feb., 1961 In Russian.

The position of the singularity is determined for diagrams t describe the scattering of two particles. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 474-7 (Aug., 1961)].

16716 COMMUTATION FUNCTION OF A NONLINEAR MESON FIELD. D.Ivanenko and D.F.Kurdgelaidze.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1072-5 (April, 196 In Russian.

A new definition of the commutation function is proposed. Nonlinear meson fields are considered and, in particular, and expression for the commutation function is presented. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 756 (Oct., 1961)].

16717 THE CAUSE OF DISAPPEARANCE OF THE RENORM IZED CHARGE IN THE LEE MODEL. D.A.Kirzhnit
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 417-22 (Aug., 1 In Russian.

With a model which is a relativistic generalization of the

ok—van Hove and Lee models, it is shown that the difficulties latter model are due to violation of the Bloch compatibility on but not of crossing symmetry. A covariant S-matrix exists Lee model only if the renormalized charge vanishes. It is hat the Bloch condition in its usual form is too rigorous. A al compatibility condition is formulated which contains only nalized quantities. [English translation in: Soviet Physics—(USA)].

718 FIELD THEORY WITH NONLOCAL INTERACTION. I. CONSTRUCTION OF THE UNITARY S-MATRIX.
irzhnits.
sper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 551-9 (Aug., 1961).
sian.
is found that the impossibility of solving the nonlocal naga—Schwinger equations and the absence of similar ilties in the Lagrangian approach can be explained by the fact ese approaches correspond to two significantly different non-field theories and not to two different representations of one theory. With help of the simple representation of the local rix in terms of retarded commutators, derived in the present a unitary S-matrix is constructed which corresponds to non-interaction. This matrix is completely relativistically ant and in the local limit goes over to the usual S-matrix. sh translation in: Soviet Physics—JETP (USA)].

3719 DISPERSION RELATIONS AND HIGH ENERGY LIMITS IN QUANTUM FIELD THEORY. III. S.Aramaki.
r. theor. Phys. (Japan), Vol. 25, No. 6, 981-8 (June, 1961).
For Pt II see Abstr. 12066 of 1961. It is shown that pion—nuc- forward scattering amplitude must have zeros on the complex gy plane. This is derived by imposing the necessary condition e existence of solutions on the dispersion relation for pion—on forward scattering. By extending this result to the case of n propagator, discussions against perturbation theory are made. ly by applying this necessary condition to the dispersion re- given by Goldberger (Abstr. 8486 of 1955), it is concluded ither the pion—nucleon total cross-sections increase at very energies or Goldberger's dispersion relation has no solution.

16720 RECENT PROGRESS IN THE DISPERSION THEORY OF PION—NUCLEON INTERACTIONS. S.Fubini.
mod. Phys. (USA), Vol. 33, No. 3, 455-6 (July, 1961).
Conference on Strong Interactions Paper, University of fornia, Dec., 1960 (see Abstr. 10847 of 1961). Reviews briefly ent attempts to understand low-energy pion physics using two-nsional dispersion relations. R.J.N.Phillips

16721 DOUBLE DISPERSION RELATIONS FOR POTENTIAL SCATTERING. V.I.Mal'chenko.
eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 546-8 (Feb., 1961).
ssian.
The analytic properties are studied of the scattering matrix ,t) as a function of t for real k^2, where t is the square of the entum transfer, and k^2 is the square of the momentum. The ntials treated are of the form $F(r)r^{-1}e^{-\alpha r}$. [English trans- n in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 381-2 ., 1961)].

PERTURBATION THEORY OF STRANGE PARTICLE EFFECTS BARYON MASS LEVELS. See Abstr. 16967

16722 SOME CONVERGING EXAMPLES OF THE PERTURBATION SERIES IN THE QUANTUM FIELD THEORY.
ato.
gr. theor. Phys. (Japan), Vol. 26, No. 1, 99-122 (July, 1961).
Properties of the Hamiltonian operator of the quantized field studied in the framework of the theory of Hilbert space. The d source theory and the boson—fermion interaction are mainly estigated in the cases of both discrete and continuous spectra. total Hamiltonian operator is defined first in a domain dense in Hilbert space, under the condition that the interaction form fact- in the momentum space is "square integrable". It is then shown the total Hamiltonian as a self-adjoint operator can be deter- ned in terms of the perturbation series for every finite value of coupling constant if the boson mass is non-zero and is the unique f-adjoint extension of the symmetric operator defined initially. the boson—fermion interaction with continuous spectrum, some itional condition on the interaction form factor is needed. The perturbation series of the S-matrix element for scattering is discussed in the framework of the wave packet formulation.

16723 RELATION BETWEEN THE EQUATIONS FOR PARTIAL AMPLITUDES AND FOR SPECTRAL FUNCTIONS.
Yu.A.Simonov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 626-9 (Feb., 1961).
In Russian.
It is shown how the Chew—Mandelstam equations (Abstr. 13019 1960) for the partial wave amplitudes can be deduced from the equations for the Mandelstam spectral functions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 436-8 (Aug., 1961)].

16724 SINGLE PARTICLE EXCITATIONS AND SUPERFLUIDITY IN SYSTEMS CONSISTING OF FERMI PARTICLES WITH AN ARBITRARY INTERACTION. APPLICATION TO THE NUCLEUS. A.B.Migdal.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 684-97 (Feb., 1961).
In Russian.
A system of equations describing single particle excitations for excitation energies small compared to the chemical potential of the system can be obtained for an arbitrary interaction by investigating the analytic properties of the Green's function, taking pair correlation into account. Equations are obtained which describe the excited states of a system of a finite number of particles up to terms of order $N^{-1/3}$. It is indicated how the results obtained can be applied to real nuclei. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 478-87 (Aug., 1961)].

ELEMENTARY PARTICLES

16725 A NEW TECHNIQUE IN THE STATISTICAL MODEL OF PARTICLE PRODUCTION. T.Ericson.
Nuovo Cimento (Italy), Vol. 21, No. 4, 605-32 (Aug. 16, 1961).
A new method is introduced to account for conservation laws in the statistical model of particle production. The approach becomes exact in the limit of high multiplicities; it leads to simple analytical expressions which allow immediate estimates of the influence of the various conservation laws under different circumstances. Momentum conservation is shown to have little influence on the energy spectra of the emitted particles; its consequences for the angular correlation of particles are studied. The statistical weight factors, which result from the coupling of the isospin vectors of the emitted particles with isospin conservation imposed, are shown to be well represented by semi-classical expressions; the dependence of the weight factors on total isospin and multiplicity becomes obvious. The general effects of angular momentum conservation in the statistical model are studied; the angular distributions are forward—backward symmetric in the c.m. system, a prediction specific to the model and a suitable test to its validity. In the classical approximation the angular distribution is forward—backward peaked, though not more than a limiting distribution $1/\sin\theta$, where θ is the angle of the particle with the beam direction. Angular momentum conservation leaves energy spectra nearly unchanged, while multiplicities are strongly affected by it; the effective interaction volumes in nucleon—antinucleon annihilation and nucleon—nucleon collisions are shown to be approximately the same, when this effect is taken into account.

16726 ANTIPARTICLES. E.Amaldi.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 2, 101-31 (1961).
In Italian.
Reviews, and summarizes in tabular form, existing experimental and theoretical data about antiparticles of intermediate and heavy mass, including a discussion of their interactions with corresponding natural particles. J.W.Gardner

Photons

16727 γ-RAYS FROM A NUCLEAR EXPLOSION. O.I.Leipunskii.
Atomnaya Energiya (USSR), Vol. 6, 49 (1959). In Russian. English translation in: Reactor Sci. (GB), Vol. 11, No. 2-4, 184-90 (Feb., 1960).
The γ-emission in a nuclear explosion is discussed. The effect

of shock waves and air heating on the γ-ray transmission is examined, and the occurrence of capture radiation is taken into account. γ-ray doses are calculated. The dose increases more rapidly than in proportion to the total energy release, because of shock wave effects. As a function of time the dose rate is shown to pass through a minimum and a maximum. The γ-radiation contains a hard component which propagates for long distances.

16728 ANGULAR CORRELATION OF BETA—GAMMA COINCIDENCES IN THE COMPTON EFFECT.
F.W.Van Name, Jr, and J.W.Koch.
Canad. J. Phys. Vol. 39, No. 8, 1212-15 (Aug., 1961).

The theoretical relation between the angle of the scattered photon and recoil electron, was verified, using a Co^{60} source with targets of beryllium and carbon. V.M.Rout

16729 DISPERSION RELATIONS FOR COMPTON EFFECT IN NUCLEONS. V.K.Fedyanin.
Dokl. Akad. Nauk SSSR, Vol. 140, No. 2, 347-50 (Sept. 11, 1961). In Russian.

The author writes down the matrix element for the process and deduces by means of the usual invariance principles the dispersion relations for the amplitudes. [English translation in: Soviet Physics—Doklady (USA)]. J.H.Gunn

16730 PHENOMENOLOGICAL ANALYSIS OF PHOTON—PROTON ELASTIC SCATTERING. K.Berkelman.
Nuovo Cimento (Italy), Vol. 21, No. 4, 633-47 (Aug.16, 1961).

Recent experimental data on Compton scattering by the proton at energies above 300 MeV suggest an extension of previous phenomenological calculations. The present model takes into account the Thompson and magnetic moment scattering, the electric dipole scattering from the virtual charged pion current, and the "Low diagram" dependent on the π^0 mean life. The resulting differential cross-section is in qualitative agreement with the available data. The polarization of the recoil proton and the dependence on incident photon polarization are also calculated. Above 500 MeV the cross-sections for unpolarized and polarized photons and the recoil proton polarization are all quite sensitive to the π^0 mean life.

16731 POLARIZATION PHENOMENA IN THE COMPTON EFFECT. G.V.Frolov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1829-36 (Dec., 1960). In Russian.

Expressions for all coefficients characterizing polarization phenomena in the Compton effect are derived in terms of form factors that enter in the scattering amplitude. Relations derived from the invariance of the scattering amplitude under time inversion and also from crossing symmetry are established between these coefficients. The relations derived have a relativistically invariant form. The results are employed to compute the polarization of recoil electrons produced in the scattering of unpolarized photons on unpolarized electrons. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1277-81 (June, 1961)].

16732 SCATTERING OF LOW-ENERGY PHOTONS ON A SYSTEM WITH SPIN $\frac{1}{2}$. V.A.Petrun'kin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1148-54 (April, 1961). In Russian.

An expression for the scattering cross-section of low-energy photons on a system with spin $\frac{1}{2}$ is obtained within the framework of the local theory, with an accuracy up to terms quadratic in frequency. In addition to the constants e, M, and λ (which represent the charge, mass, and anomalous moment of the system respectively), three other parameters, α, β, and $< r_e^2 >$ (representing, respectively, the electric and magnetic polarizabilities and the mean-square radius of the charge distribution of the system) also appear in the cross-section formula. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 808-12 (Oct., 1961)].

16733 THEORY OF SCATTERING OF HIGH ENERGY PHOTONS BY PHOTONS. S.S.Sannikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 467-77 (Aug., 1961). In Russian.

Scattering of high-energy photons by photons is investigated by the dispersion relation technique. The cross-sections for zero and small-angle scattering and also the total scattering cross-section are determined. [English translation in: Soviet Physics—JETP (USA)].

16734 THE LOW ENERGY LIMIT OF THE γ—N SCATTE AMPLITUDE AND CROSSING SYMMETRY.
L.I.Lapidus and Chzhou Guan-Chzhao [Chou Kuang-chao].
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 491-4 (Aug., In Russian.

The low energy limit for the γ—N scattering amplitude is with the aid of single-nucleon invariant amplitudes. Subseque terms in ν for $Q^2 = 0$ and the expression for the limiting value first derivative in Q^2 for $Q^2 \to 0$ can be obtained by taking into account the conditions of crossing symmetry. [English trans in: Soviet Physics—JETP (USA)].

16735 SCATTERING OF γ-RAYS IN LIQUID He^3.
A.A.Abrikosov and I.M.Khalatnikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 544-8 (Aug., In Russian.

Detailed formulae are derived for the frequency and angu distributions of scattered radiation. Numerical estimations i an appreciable magnitude for the effect which can thus be use determining the velocity of "zero sound" in He^3. [English tra in: Soviet Physics—JETP (USA)].

16736 ^{60}Co AND ^{198}Au γ-RAY ALBEDO OF VARIOUS MATERIALS. B.P.Bulatov and E.A.Garusov.
Atomnaya Energiya (USSR), Vol. 5, 631 (1958). In Russian. English translation in: Reactor Sci. (GB), Vol. 11, No. 2-4, 1 (Feb., 1960).

Absolute values of the energy albedos of various materia γ-rays from Co^{60} (1.17, 1.33 MeV) and Au^{198} (0.410 MeV) were determined experimentally, the primary beam being incident angles of 0^0, 45^0, and 60^0. Albedo magnitudes were studied as functions of the effective atomic number and thickness of the scattering material and the angular distribution and spectral composition of the scattered radiation were determined. An ionization chamber and type Roentgen X-5 photographic plate used to determine the energy flux of the primary radiation an intensity of the scattered radiation was measured using a gas counter having a sensitivity which was practically constant ov the γ-ray spectrum. The lead absorption method was used to determine the spectral composition of the scattered radiation

16737 ABSORPTION OF HIGH ENERGY PHOTONS IN T UNIVERSE. A.I.Nikishov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 549-50 (Aug. In Russian.

The probability per unit length of transformation into an electron pair of a 10^{12} eV γ-quantum colliding with a thermal is calculated. If the energy density of thermal photons in inte galactic space is $W = 0.1$ eV cm^{-3}, the probability will be $7 \times$ Thus if the distance traversed is greater than 10^{28} cm the att of the γ-quantum flux may be appreciable. [English translati Soviet Physics—JETP (USA)].

MULTIPLE SCATTERING CORRECTIONS FOR COLLIM
See Abstr. 16440

16738 AN INTENSITY CALIBRATION OF THE TWO METRE CURVED-CRYSTAL SPECTROMETER.
W.F.Edwards, J.W.M.Dumond and F.Boehm.
Nuclear Phys. (Internat.), Vol. 26, No. 4, 670-80 (Sept., 1961)

The 2 m curved-crystal diffraction spectrometer at the California Institute of Technology was calibrated to permit p relative intensity measurements of gamma rays or X-rays o energy range 60 to 400 keV. The curved quartz crystal [2 m (310) planes] was found to have a dependence of reflectivity I upon energy E given by $I/I_U = (E_o/E)^{1.987 \pm 0.023}$, where E_o is a reference energy within the range of the calibration. The re intensity uncertainty, from sources other than counting rare statistics, is now of the order of 3% or less for gamma rays differing in energy up to a factor of four.

16739 EVALUATION OF PHOTOPEAKS IN SCINTILLAT GAMMA-RAY SPECTROMETRY. W.Zimmerma
Rev. sci. Instrum. (USA), Vol. 32, No. 9, 1063-5 (Sept., 1961).

Describes a simplification of the Boekelheide method (Ab 19972 of 1960) for the determination of energy resolution. C.F.B

APPARATUS AND ANALYSIS FOR SUM-COINCIDENCE 40 (n,γ) SPECTROMETER. J.E.Draper and A.A.Fleischer. ... r Instrum. and Methods (Internat.), Vol. 9, No. 1, 67-77 ...960).
...paratus is described for analysing two-step cascades of ... capture gamma-rays by the sum-coincidence method and ...eration is given to the types of results which can be obtained. ...led analysis is given of detection efficiency and peak shapes ... ir dependence on the characteristics of the sum discriminator. ... l background effects are analysed quantitatively such as back- ...ing between scintillators, annihilation photon transfer be- ... scintillators, cascades which terminate only near to the ground ...hree-photon cascades and uncertainties caused by unknown ... r correlations.

THE EMISSION SPECTRUM OF A NON- 741 RELATIVISTIC FREE ELECTRON IN AN IONIZED ... L.Galatry.
... s. Radium (France), Vol. 22, No. 8-9, 481-8 (Aug.-Sept., 1961). ... nch.
Fourier integral theory of the radiation by a free electron ... posed. Application is made to bremsstrahlung and cyclotron ... ion, and cases are studied where dynamic friction effects and ...n of the trajectory around the lines of force of a magnetic ...re no longer negligible.

BREMSSTRAHLUNG OF STRONTIUM ENAMEL. 742 A.Tumul'kan and N.Damburg.
... PSR Zinat. Akad. Vestis (USSR), No. 8 (157), 59-62 (1960). ...ssian.
...he effective yield and hardness of bremsstrahlung were studied ... a source of strontium enamel itself and a source with trans- ...on targets of Al, Sn and Pb of various thicknesses. The ...s showed that for Al the yield scarcely changed with in- ...ing target thickness, but for Sn and Pb there was an obser- ... decrease. The softest radiation was given by a source with- ... target and the hardest when a Pb target was used. The hard- ...increased with the target thickness. An enamel containing Y^{90} provides a possible basis for the preparation of industrial ...es of bremsstrahlung. E.A.Sanderson

BREMSSTRAHLUNG FROM A LONGITUDINALLY 743 POLARIZED ELECTRON WITH ACCOUNT OF THE ...E SIZE OF THE NUCLEUS. B.K.Kerimov and F.S.Sadykhov. ...ksper. teor. Fiz. (USSR), Vol. 40, No. 2, 553-60 (Feb., 1961). ...ssian.
...he effect of the finite size of the nucleus on the angular distri- ... of circularly-polarized bremmsstrahlung emitted by a ...udinally polarized high-energy electron is considered. An ...ssion for the angular distribution of external bremsstrahlung ...ived by taking into account the mean square radius $\langle r^2 \rangle$ of ...uclear charge distribution and the longitudinal spin correlation ...en the initial electron state and emitted γ-quantum. A ...ula is deduced for the effect of the finite nuclear size on the ...ar dependence of the degree of circular polarization of the ...sstrahlung. [English translation in: Soviet Physics—JETP ..., Vol. 13, No. 2, 387-92 (Aug., 1961)].

CIRCULAR POLARIZATION OF BREMSSTRAHLUNG 6744 EMITTED BY A LONGITUDINALLY POLARIZED ...CTRON IN WEIZSÄCKER—WILLIAMS METHOD. S.Sarkar. ...o Cimento (Italy), Vol. 21, No. 3, 410-15 (Aug. 1, 1961).
...he method of Weizsäcker (1934) and Williams (1935) is ...ed here to calculate the circular polarization of bremsstrahlung ...uced in the field of a nucleus by a longitudinally polarized ...ron. This method, valid only for extremely high energies of the ...ron, simplifies the calculations by reducing the problem to one ...mpton scattering in a suitable Lorentz frame.

CIRCULAR POLARIZATION OF BREMSSTRAHLUNG 6745 FROM LONGITUDINALLY POLARIZED PRIMARY ...CTRONS. H.Banerjee.
... Nat. Inst. Sci. India A, Vol. 26, No. 5, 502-6 (Sept. 26, 1960).
...he estimation of the circular polarization of bremsstrahlung ...nsiderably simplified if one considers the primary electron to ...ngitudinally polarized. In fact, it is shown that for relativistic ...gy and small angle approximation an idea can be had of both the ...e and the magnitude of the circular polarization of the ...sstrahlung without making use of any explicit representation of the γ-matrices and subsequent expansion of the matrix elements. From the generality of the arguments it would also be apparent how, under similar restrictions, the method can be employed in considering the polarization phenomena in other processes, e.g. the photoelectric effect in the K-shell.

VAVILOV—CHERENKOV EFFECT AND "BOHR 16746 RADIATION" PRODUCED BY A BEAM OF CHARGED PARTICLES IN A DISPERSIVE MEDIUM. J.Neufeld and H.Wright. Phys. Rev. (USA), Vol. 124, No. 1, 1-16 (Oct. 1, 1961).

An electron beam interacting with a dispersive (atomic or molecular) medium produces two intense sources of instability that are represented by a growing longitudinal wave and a growing transverse wave. The longitudinal wave has frequencies that are equal to the atomic binding frequencies of the surrounding medium and is designated as the "Bohr wave". The transverse wave has frequencies determined by the Vavilov—Cherenkov criterion and is similar to the Vavilov—Cherenkov wave produced by a single particle interacting with the medium. These sources of instability are "continued" into lower frequency ranges in which they produce growing waves of a "hybrid" type that are characterized by an electric vector having both longitudinal and transverse components. The longitudinal and transverse waves represent the "fundamental modes" that exist in the medium in the absence of the beam. The perturbation produced by the beam is responsible for the instability of the fundamental modes and for the occurrence of the coupling between these modes. The coupling produces electromagnetic waves in which the electric field has a longitudinal component. The conditions for coupling and the character of the instabilities are investigated.

CHERENKOV RADIATION. 16747 J.A.M.Cox.
Ned. Tijdschrift Natuurkde (Netherlands), Vol. 26, No. 7, 204-15 (July, 1960). In Dutch.

The apparent paradox of electromagnetic radiation being produced by an unaccelerated charged particle is resolved by considering the varying dipole moments in neighbouring atoms produced by its passage through a dielectric medium. The velocity condition, direction, group velocity and energy of Cherenkov radiation are derived by a classical Hertzian-potential treatment. Applications and analogues of the effect are briefly described. B.Meltzer

RESONANCE EFFECTS OF RADIATION IN A 16748 LAMINAR MEDIUM.
M.L.Ter-Mikaelyan and A.D.Gazazyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1693-8 (Dec., 1960). In Russian.

Resonance radiation is studied in a periodic medium which is most convenient for experimentation, that is, in a laminar medium. Laminar media consisting of sets of two arbitrary layers with different or equal thicknesses are considered. Formulae for the spectral distribution and for the total number of radiated quanta are derived. The frequency ranges (for each harmonic r = 1, 2, 3...) and the energy threshold of the radiation are determined. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1183-6 (June, 1961)].

X-rays

EFFECTIVE DEPTH OF X-RAY PRODUCTION.
See Abstr. 14619

THE INFLUENCE OF THE SPECTRAL PROFILE OF THE $K\alpha_1\alpha_2$ DOUBLET AND DIFFRACTION BROADENING ON THE INTEGRATED INTENSITIES OF HIGH ANGLE DIFFRACTIONS.
See Abstr. 15050

Neutrinos

TRANSFORMATION GROUPS AND PROPER STATES 16749 IN NEUTRINO THEORY. K.H.Tzou.
J. Phys. Radium (France), Vol. 21, No. 6, 537-43 (June, 1960). In French.

In the case of a particle of spin 1/2 and zero rest mass, the proper states generated by the inversion group G are defined in both the four-component and the two-component theories. The

constant of motion γ_5, the chirality, is intimately related to gauge invariance M, and is taken into consideration. On the other hand, due to an arbitrariness in defining the solutions in the case of zero rest mass, charge conjugation leads to gauge invariance C for a neutral particle. It is shown from the angular momentum, helicity and chirality quantum numbers that gauge invariance M is a perfect invariance, while gauge invariance C is not.

16750 THE MASS OF THE MUON'S NEUTRINO. J.Bahcall and R.B.Curtis.
Nuovo Cimento (Italy), Vol. 21, No. 3, 422-9 (Aug. 1, 1961).

The effects, on free muon production and decay, of a non-zero mass for the muon's neutrino are investigated. The quantity most sensitive to the mass of the muon's neutrino is the shape of the electron spectrum from isotropic μ^+-decay near the maximum electron energy. A probable upper limit of 5 electron masses is set on the neutrino's mass using data on the maximum electron energy, but a more accurate evaluation is possible, with current experimental techniques if data are obtained on the shape of the isotropic electron spectrum.

16751 PHOTOPRODUCTION OF NEUTRINO–ANTINEUTRINO PAIRS ON ELECTRONS. Van Zhun [Wang Jung], Ya.Fisher [J.Fischer], I.Chulli [I.Ciulli] and S.Chulli [S.Ciulli].
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 676-7 (Feb., 1961). In Russian.

The cross-section for the process $\gamma + e^- \rightarrow \mu^- + \nu + \bar{\nu}$ is calculated in the extreme relativistic approximation. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 473 (Aug., 1961)].

16752 EXPERIMENTS USING NEUTRINO BEAMS OF MESONIC ORIGIN. B.Pontekorvo. [Pontecorvo].
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1166-7 (Oct., 1960). In Russian.

Discusses production of high-energy neutrino beams and experiments to be performed with them. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 4, 812 (April, 1961)].
P.K.Kabir

Electrons

16753 THE CERENKOV SELF-EXCITATION OF THE ELECTRON. T.Erber.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 714-16 (April, 1961).

A charged particle having internal excited states may simultaneously emit radiation and make transitions upwards into the excited states while traversing a medium at superlight velocities. This process is called Cherenkov self-excitation. The author makes a phenomenological application to electron–muon conversion. The "medium" necessary for the Cherenkov condition may be provided by the vacuum polarization in the vicinity of an atomic nucleus. In cosmic ray showers the Cherenkov self-excitation becomes operative at energies above 10^{13} eV. This process is related to the diffraction-production mechanism of Walker and Good (Abstr. 469 of 1961).

16754 SCATTERING AND ABSORPTION OF β-RAYS IN PLANE GEOMETRY. I. MEASUREMENT OF TRANSMISSION AND BACK-SCATTERING. R.Engelmann.
Nukleonik (Germany), Vol. 3, No. 4, 133-47 (Aug., 1961). In German.

Transmission and back-scattering of β-rays in the energy range 0.01-2 MeV from P^{32} and Tl^{204} were measured in a simple plane geometry. Various thicknesses of Al, Ag and Au were employed and transmission and scattering measurements were made with a 4π-counter, using coincidences between the two half-spaces. Effective mass-absorption and -scattering coefficients μ and ρ_∞ were determined for medium and large thicknesses respecitvely. See also following abstract. J.W.Gardner

16755 SCATTERING AND ABSORPTION OF β-RAYS IN PLANE GEOMETRY. II. THEORETICAL MODELS OF SCHMIDT AND ODEBLAD. R.Engelmann.
Nukleonik (Germany), Vol. 3, No. 4, 147-55 (Aug., 1961). In German.

The results mentioned in the previous abstract are compared with the theoretical models of Schmidt (1907) and Odeblad [Acta radiologica (Sweden), Vol. 48, 289 (1957)]. For an isotropic source the "μ" in Schmidt's formula [$T \sim \exp(-\mu x)$] has to be interpreted, for small x, as consisting of a "diffusion part" an a "side-scattering part". Odeblad's "μ", which takes account of maximum range and energy (R_{max} and E_{max}) gives more satisfactory agreement with experiment. For large x the exponent law goes over into a binomial law $T \sim (1 - x/R_{max})^{3.2l}$ where is a mass characterising E_{max}. J.W.G

16756 COMPARISON BETWEEN THE KINEMATICS OF ELASTIC SCATTERING OF μ-MESONS AND OF ELECTRONS. P.Kessler.
J. Phys. Radium (France), Vol. 22, No. 5, 322-4 (May, 1961). In French.

Experiments have been performed on the elastic scatteri of electrons in the region of several hundreds of MeV. The analogous experiments on the scattering of μ-mesons are in t course of preparation in several laboratories. The idea has b put forward of making parallel experiments on electrons and μ-mesons, in which the same momentum transfer occurs. Be of the difference in mass between the μ-meson and the electro kinematic conditions will be slightly different; the author cal these differences. J.H

16757 NOTE ON THE RADIATIVE CORRECTIONS FOR ELECTRON–ELECTRON SCATTERING. K.Hiida, T.Murota, M.Goto and M.Sasanuma.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 223-5 (July, 1960)

The result of Redhead (Abstr. 1388 of 1954) is verified an is shown that the appearance of terms proportional to $\alpha[\ln(E/$ is due to the fact that the cross-section is calculated in the laboratory system. See also following abstract. P.K

16758 NOTE ON THE RADIATIVE CORRECTION TO ELECTRON–ELECTRON COLLISION. H.Suura.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 225-7 (July, 1960

The results of Redhead and Polovin (Abstr. 2307 of 1957) which apparently contain correction terms proportional to $\alpha[\ln(E/m)]^2$, are shown actually to correspond to the Schwing corrections for scattering by a Coulomb field, i.e. proportion to $\alpha \ln(E/m) \ln(E/\Delta E)$, when the inelastic cross-section is evaluated in the c.m. system instead of the laboratory system See also preceding abstract. P.H

16759 HIGH-ENERGY ELECTRON–ELECTRON SCATT V.N.Baier and S.A.Kheifets.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 613-15 (Feb., 1 In Russian.

The cross-section for large-angle scattering is calculate the double logarithmic approximation. [English translation in Soviet Physics–JETP (USA), Vol. 13, No. 2, 428-9 (Aug., 196

INELASTIC SCATTERING OF HIGH-ENERGY ELECTRO ON CARBON. See Abstr. 17088

16760 THE ABSOLUTE MEASUREMENT OF β-SPECTR BY 4π SCINTILLATION SPECTROMETRY. E.Corompt and R.Bouchez.
J. Phys. Radium (France), Vol. 21, No. 5, 483-6 (May, 1960). In French.

Low and Mean Energy, Nuclear Physics Colloquium, Gre 1960 (see Abstr. 12029 of 1961). A 4π β-scintillation spectro was constructed with two 53 AVP photomultipliers and two ac ed polystyrene scintillators operated at - 20°C. The β-spectr of $Sr^{90} + Y^{90}$; S^{35} and P^{32} are analysed by the Kurie plot metho which enables the reconstitution of the spectrum at low energ and the extrapolation of the number of soft background electr Theoretically, this method gives an absolute measurement wi 1 % precision. It can however be improved by lowering the threshold (i.e. by selecting the photomultiplier and by the use scintillators with a better luminescence yield), and by the me of coincidences, which reduces the background. The difficult not in the physical measurement but in the manipulation of th radioactivity of the element.

61 PROPERTIES OF A BETA-SPECTROMETER OF THE SIEGBAHN–SLATIS TYPE.
ommier, M.Chabre, J.Crançon and H.Vialettes.
s. Radium (France), Vol. 21, No. 5, 493-5 (May, 1960).
nch.
ow and Mean Energy Nuclear Physics Colloquium, Grenoble, see Abstr. 12029 of 1961). A long-lens β-ray Siegbahn– spectrometer was examined. The best resolution found is with Th B. Under normal conditions 3% transmission was ed with 1.5% resolution. Conversion lines and continuous a were studied, and the accuracy in the spectrum shape may 1%.

LASTIC SCATTERING OF LOW ENERGY POSITRONS BY S. See Abstr.17282

62 THE ANNIHILATION OF POSITRONS IN FLIGHT. P.Kilian.
ys. (Germany), Vol. 164, No. 4, 416-24 (1961). In German.
he differential cross-section at 0° was measured with foils ite, Al, Cu, Ag, Sn, Au, and Pb. Positrons from Cu^{64} and Co^{56} nergies of 400, 600, 800, and 1000 keV were selected by s of a magnetic spectrometer of the Kofoed–Hansen type, e annihilation was detected in a telescope consisting of three llation counters. The experimental results were compared heoretical values computed from the two-quantum cross- n by taking into account the effect of multiple scattering of sitrons. The agreement is good for light elements,within a tical accuracy of 10%. For heavy elements the experimental was found to be 15% greater than the theoretical value, could perhaps be attributed to one-quantum annihilation.

763 MOMENTUM AND ANGULAR DISTRIBUTION OF RECOIL ELECTRONS IN TRIPLET PRODUCTION.
Mohanty, E.H.Webb, H.S.Sandhu and R.R.Roy.
Rev. (USA), Vol. 124, No. 1, 202-5 (Oct. 1, 1961).
Ilford G-5 emulsion was bombarded by a hardened sstrahlung spectrum of maximum energy 90 MeV. In 54 433 of view of the microscopes 1935 triplets were observed, out ich 1872 triplets were measured in the energy interval of 2 MeV. Recoil momentum distributions of the low-energy er of the triplets are compared with the theory of Suh and . In addition, the angular distribution of recoil electrons is nted.

764 COULOMBIC CORRECTIONS OF THE α^5m ORDER OF POSITRONIUM ENERGY LEVELS. M.Kraev.
ad. Bulg. Sci., Vol. 14, No. 1, 19-22 (1961). In Russian.
he α^5m order corrections of the positronium energy levels at uantum number, caused by coulombic interactions, are calcu- by means of the Bethe–Salpeter equation. An equation for ΔE ived:

$$\Delta E = [\alpha^3/(16\pi m)]R^2(o)$$

alue of ΔE is equal to zero at atomic states having a non-zero nt ($l \neq 0$). A.Avraam

cleons

765 THE STRUCTURE OF THE NUCLEON CORE BY THE HARTREE APPROXIMATION. Y.Takahashi.
ar Phys. (Internat.), Vol. 26, No. 4, 658-9 (Sept., 1961).
method is proposed to investigate the structure of the nucleon A set of equations is derived to define the nucleon core and eson cloud simultaneously. The equations are formulated by a tional method which enables one to find an approximate solu- The size of the nucleon core is estimated for a non-relativistic on interacting with a neutral scalar meson. The coupling ant between nucleon and meson is given by the ratio of the of the core and the cloud. It is shown that for $f^2/4\pi \cong 1$, the ize may be about half that of the meson cloud, where the er of mesons around the nucleon is about one. The generaliza- o a more realistic case is also suggested. The renormaliza- s not considered in this paper.

766 THE RESONANT PION–PION MODEL FOR THE NUCLEON STRUCTURE. S.Bergia and A.Stanghellini.
Cimento (Italy), Vol. 21, No. 1, 155-68 (July 1, 1961).
theoretical model based on strong π–π interaction is compared with experimental data on nucleon form factors and the determination of the parameters is discussed. The qualitative evaluation of the positions of the two and three pion resonances given in Abstr. 8450 of 1961 is not in disagreement with the existing data, but a wide range of values are allowed for the parameters. The situation is not clear in view of some difficulties in the interpretation of the neutron form factors.

16767 ON THE NEUTRON–PROTON MASS DIFFERENCE. G.Papini.
Nuovo Cimento (Italy), Vol. 21, No. 2, 373-5 (July 16, 1961).
Calculation to second order in e^2, using the latest form factor data. J.E.Paton

16768 THE NUCLEON CORE IN HIGH ENERGY NEUTRINO PROCESSES. N.Cabibbo.
Nuovo Cimento (Italy), Vol. 20, No. 2, 413-15 (April 16, 1961).
New data on proton form factors are used in previous theory (Abstr. 17300 of 1960) of $\nu + N \rightarrow N + e$ reactions. It is shown that such experiments could give information about the inner structure of the nucleon. J.S.Dowker

16769 ELASTIC SCATTERING OF NUCLEONS ON A TARGET WITH SPIN 1. P.Winternitz.
Czech. J. Phys., Vol. 11, No. 7, 482-9 (1961). In Russian.
A method, by means of which it is possible to reconstruct a potential on the basis of data on elastic scattering, is investigated for the case of scattering of nucleons on targets with spin 1. Formulae are given which express the relations between a phenomenological potential and the elements of the scattering matrix.

16770 ISOTOPIC SPIN DEPENDENCE OF NUCLEON–NUCLEON CROSS-SECTIONS BETWEEN 600 AND 1000 MeV. G.Martelli, H.B.van der Raay, R.Rubinstein, K.R.Chapman, J.D.Dowell, W.R.Frisken, B.Musgrave and D.H.Reading.
Nuovo Cimento (Italy), Vol. 21, No. 4, 581-92 (Aug. 16, 1961).
The ratio of the differential cross-section for p–p and p–n scattering at 90° in the c.m.s. was measured at three different energies, between 600 MeV and 1000 MeV, using fast scintillation counters in conjunction with magnetic momentum analysis. The value of this ratio decreases markedly with increasing energy, from 3.04 ± 0.56 at 595 MeV, to 1.00 ± 0.18 at 775 MeV and to 0.683 ± 0.097 at 1 010 MeV, showing an enhancement of the scattering amplitude in the T = 0 state above 600 MeV. It is shown how this behaviour may be related to the second resonance in π–p scattering.

16771 MODIFIED ANALYSIS OF NUCLEON–NUCLEON SCATTERING. IV. p–p SCATTERING BETWEEN 9.68 AND 98 MeV.
M.H.MacGregor, M.J.Moravcsik and H.P.Noyes.
Phys. Rev. (USA), Vol. 123, No. 5, 1835-9 (Sept. 1, 1961).
For earlier work see Abstr. 2543, 12931 of 1960. Proton–proton scattering experiments at 9.68, 18.2, 19.8, 25.63, 39.4, 46, 66, 68.3, 95, and 98 MeV are analysed under the assumption that the higher partial waves are correctly represented by the one-pion exchange contribution (OPEC). Although the data do not determine a unique phase shift set at any energy, the theoretically reasonable requirement that the $^1D_2$ phase be positive and the $^3P_2$–$^3F_2$ coupling parameter be negative at 68 and 98 MeV singles out the following solutions (nuclear-bar phase shifts in degrees):

Energy	$^1S_0$	$^1D_2$	$^3P_0$	$^3P_1$	$^3P_2$	ϵ_2
68.3 MeV	30.45°	2.62°	18.59°	−10.49°	6.69°	−2.38°
95 MeV	22.18°	3.87°	14.24°	−11.98°	11.17°	−2.78°

This solution type can be qualitatively followed to both lower and higher energies. Such an extension (a) has been shown by Riazuddin to be required by triplet nucleon–nucleon dispersion relations at 4 MeV, (b) is consistent with the best solutions at both 210 and 310 MeV, (c) is qualitatively similar to the requirements of the best phenomenological and semiphenomenological potential models, and (d) carries the signature of the P phases required for consistency with the final-state interaction in the photodisintegration of the deuteron. An attempt to tie solutions at 9.68, 25.63, and 39.4 MeV together using a three-parameter P-phase energy dependence derived by Fubini and Stanghellini, with two of the parameters determined by single pion exchange, was qualitatively consistent but quantitatively unsuccessful. Although on the above

grounds, the authors believe that this is the physically correct solution type in this energy range, the reader is warned that the solution is experimentally not unique, and that the phase shifts can be varied by a few degrees in a correlated way without doing undue violence to the data. On both counts, it is highly desirable that the triple scattering experiments needed for refining these values be carried through. That only two such experiments at a single angle are needed has recently been shown by Iwadare.

16772 SHAPE-INDEPENDENT THEORY OF HIGH-ENERGY NUCLEON—NUCLEON SCATTERING. L.A.P.Balázs.
Phys. Rev. (USA), Vol. 124, No. 2, 602-11 (Oct. 15, 1961).

A shape-independent formula for the phase shifts, approximately valid over wide energy ranges, is derived, assuming only general properties of the wave-function and potential. It is found to approximately reproduce the S, P, and D proton—proton phase shifts in the ranges 10-150 MeV and 10-310 MeV with two, or at most three free parameters per state. A generalization, which includes part or all of the outer potential exactly, is derived at the same time.

16773 NON-STATIC EFFECT IN THE T = 0 TWO-NUCLEON INTERACTION. T.Hamada.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 222-3 (July, 1960).

Whereas the p—p scattering data at 310 MeV cannot be understood except in terms of non-static potentials, the situation is not as clear in the T = 0 states. In this note, it is pointed out that any static potential which fits the deuteron ground-state properties also predicts a $^3D_2$ phase-shift exceeding 0.78 at 300 MeV. This contributes at least 20.7 mb to the n—p scattering cross-section, leaving only 3-4 mb as the contribution of all the other T = 0 states, since the experimentally observed cross-section is 35 mb, of which about 11 mb may be accounted for as the contribution of the T = 1 states, on the basis of the p—p data at the same energy. This indicates the importance of non-static effects in the T = 0 states at 300 MeV, and if these are to be represented by a spin—orbit potential it must be repulsive in the $^3D_2$ state, in agreement with the choice of Signell and Marshak (Abstr. 2468 of 1958) and of Gammel and Thaler (Abstr. 6137 of 1958). P.K.Kabir

16774 QUASI-ELASTIC PEAK IN HIGH-ENERGY NUCLEON—NUCLEON SCATTERING. S.D.Drell and K.Hiida.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 199-202 (Sept. 1, 1961).

The one-pion exchange model is applied to inelastic proton—nucleus scattering in order to explain a bump in the energy spectrum of the emerging protons for incident energies in the range 9-25 BeV and 20-60 milliradians scattering, as reported by Cocconi et al. (Abstr. 7243 of 1961). C.Wilkin

16775 ON THE POLARIZATION CROSS-SECTION FOR SCATTERING OF FAST NUCLEONS.
S.Chulli and J.Fisher.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 391-3 (Aug., 1961). In Russian.

Investigates the contribution of pion poles to the cross-section for the process NN→NN for the case when the polarization of one of the final nucleons is measured. It is shown that, for all angles, not only the contribution from the quadratic term but also that of the linear term vanishes. Some practical consequences of this effect are discussed. [English translation in Soviet Physics—JETP (USA)].

16776 RANGE OF THE NUCLEON—ANTINUCLEON ANNIHILATION POTENTIAL. A.Martin.
Phys. Rev. (USA), Vol. 124, No. 2, 614-15 (Oct. 15, 1961).

It is shown that the assumption of the validity of the Mandelstam representation for nucleon—antinucleon scattering leads to a potential, fitting the data at a given energy, with an imaginary part, the range of which cannot exceed half the nucleon Compton wavelength.

Protons

16777 ESTIMATE OF THE UPPER LIMIT OF THE CHARGE-EXCHANGE CROSS-SECTION FOR THE pn INTERACTION AT 8.5 BeV. V.A.Nikitin and É.M.Tsyganov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1027-30 (April, 1961). In Russian.

Studied by the photographic emulsion technique and found to be 0.46 ± 0.15 mb. [English translation in: Soviet Physics—JE (USA), Vol. 13, No. 4, 722-4 (Oct., 1961)].

16778 NUCLEAR EXCITATION AND MULTIPLE PRO IN PROTON—NUCLEON COLLISIONS AT CERN ENERGIES.
G.Cvijanovich, B.Dayton, P.Egli, B.Klaiber, W.Koch, M.Nik R.Scheenberger, H.Winzeler, J.C.Combe, W.M.Gibson, W.O M.Scheenberger and G.Vanderhaeghe.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1012-16 (June 1, 1961

Analyses 1241 stars produced by protons of mean mom 23.5 GeV/c in G5 emulsion according to the numbers of thic thin tracks. The mean free path of 36.6 ± 1 cm for star pr is in agreement with the values found at 6.2 and 9.0 GeV. R estimates of the p—p inelastic and elastic cross-sections ar obtained. Angular distributions are given for shower partic for grey proton tracks. A.

16779 PHOTON—PROTON COLLISION AT (250-800) M S.Minami.
Nuovo Cimento (Italy), Vol. 21, No. 3, 401-9 (Aug. 1, 1961).

A simple analysis of the experimental results for photo production of pions at (250-800) MeV is made and photon—p scattering at these energies is described in terms of shado scattering due to the photoproduction of pions. The total cr sections for photon—proton scattering show the existence of and broad resonance corresponding to the second resonance photoproduction of pions at about 750 MeV. Since the reson behaviour is strongly reflected in photon—proton scattering process may be regarded as one of the most suitable reacti the study of the character of the second resonance.

16780 A SEARCH FOR BREMSSTRAHLUNG PRODUC ELASTIC SCATTERING OF NEGATIVE π-MES PROTONS. P.F.Ermolov and V.I.Moskalev.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 322-6 (Aug In Russian.

In not one of 1500 events of elastic scattering of 128 an MeV π⁻-mesons by protons in a hydrogen diffusion chamber found that the angle of emission of the recoil proton exceed more than 3° the angle computed on basis of conservation la this basis the upper limit for the cross-section for bremsst emitted by π⁻-mesons on nuclear forces is derived and found 5.10^{-29} cm². [English translation in: Soviet Physics—JETP

16781 PROTON—PROTON TRIPLE SCATTERING PARAMETERS R AND A AT 213 MeV.
A.C.England, W.A.Gibson, K.Gotow, E.Heer and J.Tinlot.
Phys. Rev. (USA), Vol. 124, No. 2, 561-74 (Oct. 15, 1961).

As a part of a programme to determine the p—p scatte matrix at 213 MeV the triple-scattering parameters R and measured at 30°, 40°, 50°, 60°, 70°, 80° and 90° in the centre mass system. The results are compared with a phase-shif analysis by MacGregor and Moravcsik and with the predicti the boundary condition model of Saylor, Bryan and Marshak

16782 PROTON-PROTON SCATTERING AT 155 MeV: DIFFERENTIAL CROSS-SECTION BETWEEN 3 110° c.m. C.Caverzasio and A.Michalowicz.
J. Phys. Radium (France), Vol. 21, No. 5, 314-17 (May, 196 In French.

Low and Mean Energy, Nuclear Physics Colloquium, Gr 1960 (see Abstr. 12029 of 1961). Measured in a preliminary ment, using three methods: the difference between CH_2 and simultaneous detection of scattered and recoil protons; the of pulse height spectra of particles scattered by CH_2 and C. The results are about 10% lower than those of the Harwell a Harvard groups.

16783 A PROTON—PROTON POTENTIAL. T.Hamada.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 220-2 (July, 19

A potential, consisting of a static part supplemented by quadratic spin—orbit part, is proposed which yields phase s at 310 MeV close to those obtained by MacGregor, Moravcs and Stapp (Abstr. 2543 of 1960) and also agrees with the exp mental data on the cross-section and polarization at lower energies. The predicted values of D agree with the Harvar measurements at 145 MeV, while the values of R agree rea with the Harwell measurements of this quantity. P

'84 RECENT WORK ON STRONG INTERACTIONS AT CERN. A.M.Wetherell.
nod. Phys. (USA), Vol. 33, No. 3, 382-8 (July, 1961).
:onference on Strong Interactions Paper, University of
ırnia, Dec., 1960 (see Abstr. 10847 of 1961). Total cross-
ıns for p—p, $\bar{p}$—p, K^+—p and K^-—p are reported briefly; also
on production by π^- + p at 16 GeV/c. High-energy small-
p—p scattering measurements are described at greater length;
-defined inelastic peak consistently appears about 1 GeV/c
the elastic group. R.J.N.Phillips

85 PHASE SHIFT ANALYSIS OF pp SCATTERING AT 95 MeV.
orovikov, I.M.Gel'fand, A.F.Grashin and I.Ya.Pomeranchuk.
csper. teor. Fiz. (USSR), Vol. 40, No. 4, 1106-11 (April, 1961).
ssian.
five-parameter analysis of the experimental data (cross-
n, polarization, depolarization) is performed by the "ravine"
·ical method. A broad complex range of solutions is ob-
, which cannot be described by specifying the local minima and
matrices as in the "local" technique. The region obtained can
ided into two comparatively small regions by including some
n rotation of polarization R, obtained by extrapolating from
ies of 150, 210 and 310 MeV. [English translation in: Soviet
cs—JETP (USA), Vol. 13, No. 4, 780-4 (Oct., 1961)].

POLARIZATION OF PROTONS. See Abstr. 13970

86 SOURCES OF POLARIZED PROTONS AND DEUTERONS. R.Beurtey, A.Papineau and J.Thirion.
Cimento Suppl. (Italy), Vol. 19, No. 2, 207-20 (1961).
nch.
ives a detailed description of the construction and perform-
of polarized ion sources of protons and deuterons. A
zation of nearly 100% was obtained for protons and of about
or deuterons. Some possible improvements are suggested.
J.B.Garg

PRODUCTION OF PROTON BEAMS. See Abstr.16464

'87 ANTIPROTONIUM LEVEL SHIFTS FOR LARGE ORBITAL ANGULAR MOMENTA. A.F.Grashin.
csper. teor. Fiz. (USSR), Vol. 40, No. 2, 652-3 (Feb., 1961).
ssian.
evel shifts due to a single-meson interaction are calculated
e proton—antiproton system. [English translation in:
Physics—JETP (USA), Vol. 13, No. 2, 455 (Aug., 1961)].

788 ANTIPROTON—PROTON INELASTIC INTERACTIONS AT 1.61 BeV/c AND THEIR USE FOR A TEST OF GE-CONJUGATION INVARIANCE IN STRONG INTERACTIONS.
n-huu Xuong, G.R.Lynch and C.K.Hinrichs.
Rev. (USA), Vol. 124, No. 2, 575-9 (Oct. 15, 1961).
he reactions $\bar{p} + p \rightarrow \bar{p} + p + \pi^0$, $p + \bar{n} + \pi^+$, and $p + \bar{n} + \pi^-$
investigated for antiprotons of 1.61 BeV/c. The cross-
ns were measured and found to be 1.6 ± 0.3, 1.15 ± 0.3, and
0.22 mb, respectively. The combined inelastic (nonannihila-
:ross-section is estimated to be 5.3 mb, and the annihilation
-section 51 ± 3 mb. The angular and energy distributions are
ıted. In all cases the antinucleons are peaked forward and
cleons backward in the centre-of-mass system. These events
: used to check charge-conjugation invariance in strong
ctions.

'89 ANTIPROTON—PROTON AND PROTON—PROTON TOTAL CROSS-SECTION FROM 4 TO 20 BeV/c.
ndenbaum, W.A.Love, J.A.Niederer, S.Ozaki, J.J.Russell
.C.L.Yuan.
Rev. Letters (USA), Vol. 7, No. 5, 184-8 (Sept. 1, 1961).
he $\bar{p}$—p and p—p total cross-sections were measured at
als of 1 BeV/c in the momentum range 4-20 BeV/c using a
cattered beam of the Brookhaven 33 BeV proton-synchrotron.
:les in the beam were identified by a focusing gas Cherenkov
:r. The transmission through a 10 ft long hydrogen target
easured using scintillation counters, and repeated for an
y target" simulated by aluminium plates. The results are in
eneral agreement with previous measurements and show that
BeV/c the $\bar{p}$—p cross-section is still falling and is greater
than the p—p by 10-20%. On the other hand the p—p cross-section is constant at 39.5 ± 1 mb in the range 10 to 20 BeV/c.
J.D.Dowell

16790 FINAL STATES OF THE ANTIPROTON—PROTON SYSTEM. G.R.Lynch.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 395-401 (July, 1961).
Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Hydrogen bubble-chamber observations of antiproton interactions at 1.6 and 2 GeV/c are reported. Cross-sections are estimated for annihilation to $\pi^+ + \pi^-$, $K^+ + K^-$ and $\Lambda + \bar{\Lambda}$, and for inelastic scattering with single pion production. Tests of charge-conjugation invariance in these processes are discussed. Pion multiplicities in annihilation are given. R.J.N.Phillips

16791 PI—PI CORRELATION IN $\bar{P}$—P ANNIHILATION. G.Goldhaber and W.Lee.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 402-5 (July, 1961).
Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). The authors discuss the effect of the proposed π—π resonance with $J = T = 1$ on the angular correlation of unlike pion pairs in the process $\bar{p} + p \rightarrow 2\pi^+ + 2\pi^-$. Available data are hard to reconcile with such a resonance if its mass is near 3.5 m_π. R.J.N.Phillips

Neutrons

16792 DEFINITION AND CALCULATION METHODS OF THE AMPLIFICATION FACTOR OF NEUTRON AMPLIFIERS. G.Fodor.
Periodica polytech., Elect. Engng (Hungary), Vol. 4, No. 3, 205-25 (1960).
Subcritical multiplier systems, neutron amplifiers, can be used for various purposes, accordingly the amplification factor can be defined in various practical ways. The most characteristic is the amplification factor which is defined as the ratio of the number of thermal neutrons absorbed in the unit of time, or the number of fast neutrons released in the unit of time on one hand, and of neutron source intensity on the other hand. The expression for the amplification factor depends, to a small extent, on applied calculation method; if the amplifier is, however, in a near-critical condition, deviations caused thereby can be neglected. Basically, only such systems can be compared which are equally far from the critical condition. The critical condition, however, is difficult to characterize by a single value. A reasonable value is the degree of criticality (s^0), the quotient of actual fissionable material quantity and of the critical fissionable material quantity. In the case of a given material composition this is equal to the quotient of the actual and of the critical volume of the active zone. A value which is characterizing on y to a lesser extent, but which, nevertheless, cannot be wholly left out of consideration, is the negative reactivity, which depends, not only on the degree of criticality, but also on material composition. In the case of a given degree of criticality (or of negative reactivity) an amplification factor can be produced by different systems. Of all the possible solutions, that one is regarded as optimum, which costs the least. It is shown that, in a near critical system flux distributions obtained by different approximate calculation methods only vary to a small extent.

16793 THE CHARACTERISTICS OF HOMOGENEOUS NEUTRON AMPLIFIERS. G.Fodor.
Periodica polytech., Elect. Engng (Hungary), Vol. 4, No. 4, 305-25 (1960).
Along principles laid down in the preceding paper the data and characteristics of various simple homogeneous neutron amplifiers are calculated.

16794 ENERGY DISTRIBUTION OF THERMAL NEUTRONS IN A FINITE SOLID MODERATOR ASSEMBLY. S.S.Jha.
Reactor Sci. (GB), Vol. 12, No. 3, 89-92 (June, 1960).
The equilibrium neutron energy spectrum inside a finite beryllium assembly was calculated by solving the energy-dependent Boltzmann diffusion equation by numerical iteration. A pulsed source of neutrons at time t = 0 was assumed. A reasonable approximation to the values given by Bhandari (1957) for the transport cross-sections was used. For small assemblies the spectrum

is found to deviate appreciably from the Maxwellian, particularly in the low energy region. The calculations also give the values of the decay constant λ of neutrons in different sizes of the assembly.

16795 TWO-NUCLEON SPIN–ORBIT FORCES AND THE DOUBLET SPLITTING IN LOW ENERGY n–α SCATTERING. Y.Takamura and R.Tamagaki.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 855-8 (May, 1961).

The author claims that recent p–p scattering experiments at 310 MeV show the necessity of strong short range spin–orbit forces. To study their effects the doublet splitting in n–α scattering is discussed. J.H.Gunn

16796 STUDY OF NEUTRON–PROTON SCATTERING IN PHOTOGRAPHIC EMULSIONS. I. ANGULAR DISTRIBUTION OF RECOIL PROTONS SCATTERED BY NEUTRONS OF THE REACTION $Li^7(d,n)Be^8$.
J.Aguilar, M.de la Cuadra and R.Font.
An.Real Soc. Espan. Fis. Quim. (Spain), Vol. 56, No. 3-4, 71-6 (March-April, 1960). In Spanish.

The results confirm the isotropy of the scattering in the centre-of-mass system up to neutron energies of 10 MeV, but they are inconclusive at higher energies, because of poor statistics. I.C.Demetsopoullos

16797 INELASTIC SCATTERING OF NEUTRONS IN SOLIDS AND LIQUIDS — A SYMPOSIUM. K.Rajagopalan.
J. sci. industr. Res. (India), Vol. 20A, No. 9, 486-9 (Sept., 1961).

A report of a symposium held at Vienna on Oct. 11-14, 1960 and organized by the International Atomic Energy Agency. Forty-four papers were presented embracing such diverse fields as neutron scattering, neutron thermalization, neutron spectroscopy, neutron spectrometry and cold neutron sources.

16798 MEASUREMENT OF THE DIFFERENTIAL EFFECTIVE CROSS-SECTION AND THE AVERAGE LOGARITHMIC ENERGY LOSS ON THE SCATTERING OF SLOW NEUTRONS BY WATER AND ICE. C.Reinsch.
Z. Phys. (Germany), Vol. 163, No. 4, 424-34 (1961). In German.

Neutrons with energies of 0.039 and 0.078 eV were scattered by thin layers of water and ice at different temperatures. Only small differences were found between the measured cross-section between water and ice. A comparison of the results with Nelkin's theory gives good agreement for $\cos\theta$ but undoubted deviations for the average logarithmic energy loss. J.F.Hill

NEUTRON DIFFUSION IN TWO ADJACENT HALF-SPACES. See Abstr. 15749

16799 A SPECIAL MODEL OF A TWO-GROUP APPROACH IN NEUTRON TRANSPORT THEORY.
R.Żelazny and A.Kuszell.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 6, 461-6 (1961).

A model for $l_1 = l_2$ (l_i denotes a mean free path for the i-th energy group of neutrons) is discussed and is shown to be soluble exactly. Two examples are dealt with: the solution of Milne's problem for a half-space and the solution of a critical problem for a slab. F.Herbut

16800 MILNE'S PROBLEM FOR A VELOCITY-DEPENDENT MEAN FREE PATH. M.Nelkin.
Nuclear Sci. Engng (USA), Vol. 7, No. 6, 552-3 (June, 1960).

The problem of the extrapolation distance for an energy-dependent mean-free-path is considered under the idealized situation of an infinite half-space with no absorption or sources and isotropic scattering. The energy transfer between neutrons and moderator is explicitly included. A variational solution for constant cross-section has been given (Abstr. 3669 of 1947) and an extension of this variational solution to the multivelocity problem appropriate for varying mean-free-path is presented. J.F.Hill

16801 MEASUREMENTS ON THE DIFFUSION LENGTH OF THERMAL NEUTRONS IN WATER FROM 25 TO 296° C.
K.S.Rockey and W.Skolnik.
Nuclear Sci. Engng (USA), Vol. 8, No. 1, 62-5 (July, 1960).

Measured in the pressure vessel of the KAPL High Temperature Critical Assembly. The diffusion length was determined by fitting an exponential to the data found by activating manganese foils wi neutrons from a small Sb–Be source. The temperature varia the diffusion length could be fairly well represented by either simple approximations — either that the transport cross-sec of water has a 1/v behaviour, or that the transport cross-sec determined from the Radkowsky prescription.

16802 AGE OF Na–Be NEUTRONS IN WATER AND KEROSENE. D.G.Foster, Jr.
Nuclear Sci. Engng (USA), Vol. 8, No. 2, 148-56 (Aug., 1960).

The age to indium resonance of nearly monoenergetic 0.9 neutrons from spherical Na–γ–Be sources was measured in and kerosene. The age from a point source is inferred by ext polation from measurements made with sources $\frac{3}{4}$ and $\frac{3}{8}$ in. in diameter. The flux age is 13.9 ± 0.2 cm² in water and 13.8 ± ± 0.2 cm² in kerosene. Calculations by the moments method 13.9 ± 0.1 cm² in each medium, inexcellent agreement with th measurements. The thermal migration area measured concu is 21.5 ± 0.4 cm² in water and 20.6 ± 0.4 cm² in kerosene. T migration area calculated from the resonance age is 22.2 ± 0 in water and 21.8 ± 0.5 cm² in kerosene. Both of these are substantially larger than the measured values.

16803 ALBEDO PROBLEM FOR A SLAB. R.Żelazny and A.Kuszell.
Physica (Netherlands), Vol. 27, No. 8, 797-9 (Aug., 1961).

Presents a new application of the method developed by C (Abstr. 3471 of 1960) in the one-velocity neutron transport th The albedo problem with prescibed incident neutron beams on surfaces of the slab, was solved by reducing the problem of s the Boltzmann equation to the problem of solving a Fredholm integral equation for the expansion coefficients.

THERMAL NEUTRON FLUX DISTRIBUTIONS IN METAL HYDROGENOUS SHIELDS. See Abstr. 17237

16804 SIMPLE PROCEDURE FOR CALCULATION OF T FERMI AGE OF LIGHT WATER. N.Papmehl.
Atomkernergie (Germany), Vol. 5, No. 10, 357-60 (Oct., 1960) In German.

In previous calculations of the Fermi age of H_2O, the sta point was always the energy–dependent transport equation. I possible to subdivide the examined lethargy range, and to sol the monoenergetic Boltzmann equation for each of the interva This procedure corresponds to summarizing the neutrons of different energies into "groups" as often done in the diffusion approximation. Its application to the calculation of the Fermi of H_2O leads to a value $\tau = 25.0$ cm², in very good agreement the theoretical value of $\tau = 25.3$ cm² obtained by many other methods. The analysis of the assumptions made in this calcu shows that the above value might be considerably too low. Re considerations should therefore show whether a better agreer with the experimental value ($\tau = 30.8$ cm²) of the Fermi age o water can be obtained.

16805 FISSION-TO-INDIUM AGE IN WATER. D.B.Lombard and C.H.Blanchard.
Nuclear Sci. Engng (USA), Vol. 7, No. 5, 448-53 (May, 1960).

A redetermination of the age τ ($= \frac{1}{6}\langle r^2 \rangle$) for neutrons of resonance energy (1.46 eV) from a point U^{235} fission source i ported. Foils were irradiated in a geometrically simple arra ment in the Penn State Reactor pool, and counted in a standar manner. The value obtained, $\tau = 27.3 \pm 0.9$ cm², is in better ment with current theory than those from previous measurem The spatial distribution found here differs most markedly fro observed in previous experiments by having a larger slope in region within a few centimetres of the source.

16806 RESONANCE CAPTURE OF NEUTRONS IN NON-HEAVY ABSORBERS. W.Rothenstein and J.Cher
Nuclear Sci. Engng (USA), Vol. 7, No. 5, 454-7 (May, 1960).

In many instances resonance capture of neutrons can be lated by one of two basic approximations. The narrow resona approximation is valid if the practical width is small compare with the maximum energy loss of a neutron in an elastic colli If the reverse is the case, the absorber atoms may be regard infintely heavy. There are cases of wide, weakly absorbing, ances however in which neither of these methods is reliable. amples of these are given. An alternative method for calcula

ınce capture for such resonances is presented and compared lonte Carlo calculations of the capture fraction in bismuth–te lattices.

307 ON THE TEMPERATURE DEPENDENCE OF THE THERMAL NEUTRON FLUX KERNEL.
nderson.
ar Sci. Engng (USA), Vol. 7, No. 5, 468-71 (May, 1960).
he thermal neutron flux kernel for a point fission source in a geneous medium is obtained analytically by representing the rmal slowing down source in a convenient functional form. alization is achieved by invoking an appropriate conservation ion. The temperature dependence is then assessed from imentally determined variation in the diffusion length and priate variation in the fitting parameters for the slowing down e. It is concluded that the kernel for water is rather insensi- change in the diffusion length, and in fact, the r^2-flux varies ood approximation for f(ρr), ρ being the temperature-depend- ecific gravity.

808 STANDARD BORON SOLUTIONS FOR NEUTRON ABSORPTION MEASUREMENTS. S.Wexler.
ar Sci. Engng (USA), Vol. 8, No. 3, 270-3 (Sept., 1960).
procedure is described for preparing deuterated boric acid ons for use in the absolute determination of the cross-section sorption of thermal neutrons and for reference standards. uitability of these solutions as standards is discussed in terms purity of the reagents, the reproducibility of preparation, ıe composition of the boric oxide used in the preparation.

809 THERMAL NEUTRON FLUX DEPRESSION BY ABSORBING FOILS. R.H.Ritchie and H.B.Eldridge.
ar Sci. Engng (USA), Vol. 8, No. 4, 300-11 (Oct., 1960).
he perturbation of a thermal neutron flux field by an absorbing considered for the case of a foil of thickness t and of lateral sions $\gg$ L, where L is the diffusion length of thermal neut- in the medium. The integral equation for "one-velocity" trans- f neutrons in the medium containing the foil is solved by a ional method in which the "eigenvalue" is closely related to the tivation. The results are compared with the predictions of othe and Skyrme theories. The Bothe and Skyrme theories are ared for the case of the finite disk-shaped foil and are shown fer primarily in the transport correction. This difference may portant in cases where L is not very large compared with the free path of neutrons in the medium. On the basis of these derations, a new analytic approximation for the activation of a foil is proposed.

810 THE TEMPERATURE COEFFICIENT OF THE RESONANCE INTEGRAL FOR URANIUM METAL AND E. E.Hellstrand, P.Blomberg and S.Hörner.
ar Sci. Engng (USA), Vol. 8, No. 6, 497-506 (Dec., 1960).
he temperature coefficient of the resonance integral for ım metal and oxide was measured over a wide temperature for rods with different diameters. The activation method was and the 106 keV γ-ray following the Np^{239} decay was measured pulse-height analyser. The resonance integral was expressed inear function of $\sqrt{T}$. The following approximate relations found.

al: $RI = RI_0[1 + 10^{-2}(0.51 + 0.5\ S/M)(\sqrt{T} - \sqrt{T_0})]$
de: $RI = RI_0[1 + 10^{-2}(0.58 + 0.5\ S/M)(\sqrt{T} - \sqrt{T_0})]$

esults were compared with calculated values published else-. The experimental values lie lower than most theoretical but in several cases there is agreement within the common of error.

811 NEUTRON SLOWING-DOWN LENGTHS.
V.P.Kochergin and V.V.Orlov.
naya Energiya (USSR), Vol. 6, 34 (1959). In Russian. English lation in: Reactor Sci. (GB), Vol. 11, No. 2-4, 177-83 . 1960).
An approximate solution is given to the integral equations for patial moments of the neutron distribution in an infinite ım with an infinite plane isotropic source. The energy-angle ents of the scattering function are expressed in terms of the imentally determined angular distributions for anisotropic ıc neutron scattering at various energies. The slowing-down lengths in ordinary water, heavy water. graphite, beryllium and BeO are calculated from the total cross-sections and angular distributions in elastic scattering for H, D, Be^9, C^{12} and O^{16}. Calculated and experimental results are in satisfactory agreement.

16812 LONG WAVELENGTH CRYSTAL SPECTROMETER AND THE NEUTRON ABSORPTION CROSS SECTIONS OF GOLD AND BORON.
F.T.Gould, T.I.Taylor, W.W.Havens, Jr, B.M.Rustad and E.Melkonian.
Nuclear Sci. Engng (USA), Vol. 8, No. 6, 453-66 (Dec., 1960).
The absorption cross-sections were measured at long neutron wavelengths with a single crystal spectrometer. Mica along with microcrystalline filters of Be and BeO was used as a monochromator for the wavelength range from 4 to 8.75 A, and for longer wavelengths a mechanical monochromator was used to remove second and higher order neutrons. Neutron beams with negligible higher order contamination were obtained with a wavelength resolution $\Delta\lambda/\lambda$ of 0.018. The total cross-section of gold for wavelengths from 5 to 11.5 A is $\sigma_t = (54.56 \pm 0.09)\lambda - (0.46 \pm 0.67)$ barns. Evaluation of the thermal neutron (2200 m/sec) absorption cross-sections gave (98.8 ± 0.3) barns for gold and (7.56 ± 6) barns for boron in glass plates for use as secondary standards.

16813 A NEW TYPE OF NEUTRON SPECTROMETER.
R.L.Bramblett, R.I.Ewing and T.W.Bonner.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 1-12 (Oct., 1960).
Neutrons are detected in a small Li^6I:Eu scintillator placed at the centre of polyethylene moderating spheres with sizes ranging from 2 to 12 in. in diameter. The efficiency of this neutron counter was experimentally determined using monoenergetic neutrons from thermal energies to 15 MeV. The counter has excellent energy sensitivity from 0.1 to 2 MeV and is particularly useful for determining the shapes of continuous neutron spectra. The pronounced difference in the efficiencies for the five sizes of spheres which was calibrated provides a basis for accurate neutron energy determination. The good γ-ray discrimination of the counter allows it to be used with a radium–beryllium neutron source. Neutron spectra from a variety of sources were determined with this counter. These include the two groups of neutrons from the $C^{14}(p,n)N^{14}$ reaction, the evaporation spectrum of the neutrons from the reaction $Rh^{103}(p,n)Pd^{103}$, the energy spectra of inelastically scattered neutrons, and the neutron spectrum from scattering of fast neutrons by the floor and walls of a building.

16814 COMPETITIVE EXTINCTION IN NEUTRON MONOCHROMATING CRYSTALS. R.R.Spencer and J.R.Smith.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 393-9 (Nov., 1960).
Large anomalies have been observed in the Bragg beam produced by Be (10$\bar{1}$1), Be(10$\bar{1}$3), Be (10$\bar{1}$0), and Be (0002) monochromators on the MTR crystal spectrometer. Instead of a smooth spectrum characteristic of a Maxwellian distribution of neutron velocities, many large dips were found. These dips appear to be caused by extinction of the beam due to Bragg reflection by planes in the crystal other than those supplying the Bragg beam to the spectrometer. Calculations of the angles at which such competition can be expected have resulted in the identification of the planes responsible for the principal dips. To establish that these anomalies are due to crystal properties, spectra produced by the (200), (220), and (240) planes of NaCl were also examined. Although a few extinction dips were observed, these were far smaller in number and amplitude than those found in Be, due to the simpler crystal structure and lower reflectivity of NaCl. These effects require careful consideration in high-accuracy experiments with the crystal spectrometer, particularly in the measurement of reactor spectra.

16815 GAS IONIZATION NEUTRON DETECTORS.
W.Dąbek, A.Kazimierski and J.Topa.
Nukleonika (Poland), Vol. 5, No. 10, 597-609 (1960).

16816 CALIBRATION OF LUTETIUM FOR MEASUREMENTS OF EFFECTIVE NEUTRON TEMPERATURES.
L.C.Schmid and W.P.Stinson.
Nuclear Sci. Engng (USA), Vol. 7, No. 5, 477-8 (May, 1960).
Investigation shows that natural Lu foils should be about 7 times more sensitive at room temperature than the Pu^{239}–U^{235} technique for neutron temperature measurement, and remains more sensitive up to about 400°C. The half-lives of the neutron-induced activities Lu^{177} and Lu^{176m} were found to be 6.74 ± 0.04 days and 3.69 ± 0.04

hr respectively. The neutron cross-section of Lu^{175} was found not to have an observable non-1/v component, so that the ratios of the induced activities may be taken as proportional to the Westcott g factor for Lu^{176}, which has a resonance at 0.142 eV in its neutron cross-section. J.E.Gore

16817 MEASUREMENTS OF NEUTRON FLUX BY SHIELDED "LONG COUNTER". H.Kobayashi.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 3, 261-5 (Sept., 1960).

Experiments were made to examine the counting efficiency and directionality of a shielded "long counter" for neutrons from a Ra–Be source. The efficiencies of the counter with and without deep holes, eight in number, made from the front into the surrounding paraffin body around the BF_3 counter, were found to be 1.9% and 1.7% respectively. The effect of neutrons scattered by the floor was also investigated.

16818 MEASUREMENTS OF NEUTRON INTENSITY BY THE USE OF MANGANESE BATH. H.Kobayashi.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 3, 266-70 (Sept., 1960).

The strength of a Ra(100 mc)–Be neutron source was measured by the use of manganese baths in cylindrical tanks of different sizes, and the method was examined from various points of view. A sample of activated Mn^{56} taken from a water solution of $MnSO_4$ in the form of Mn_3O_4 was measured by a Geiger–Müller counter with an end window, and the absolute measurement of Mn^{56} activity was made by the defined solid angle method. The manganese bath consisted of a water solution of 1 mol./l. of $MnSO_4$, the cylindrical tank having its diameter equal to its height, varying in size from 17 to 70 cm. The leakage factor of neutrons was obtained by varying the size of the bath tank. The strength of the neutron source measured with tank size of 69.3 cm in diameter and height agreed with the Belgian assayed value within an error of 10%.

16819 BF_3 NEUTRON COUNTER. H.Kobayashi.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 3, 271-80 (Sept., 1960).

For obtaining a BF_3 counter of good performance, it is essential that the counter is filled with pure BF_3. The present paper is mainly concerned in the preparation of $BF_3.CaF_2$ with a specially designed apparatus and in the filling procedure of BF_3. The counter thus prepared has a plateau length of over several hundreds volts with a slope of less than 2%.

16820 A VERSATILE, HIGH EFFICIENCY 4π NEUTRON DETECTOR.
J.B.Marion, R.J.A.Levesque, C.A.Ludemann and R.W.Detenbeck.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 297-303 (Sept., 1960).

A high efficiency 4π neutron detector was constructed which consists of 12 $B^{10}F_3$ proportional counters imbedded in a two-foot cube of paraffin. The response of this detector as a function of neutron energy was measured in the range 0.1 to 2.5 MeV by observing the yield curves for the T(p,n) and Li^7(p,n) reactions, the absolute total neutron production cross-sections for which have been accurately measured by Macklin and Gibbons (Abstr. 1257 of 1958; 8466 of 1959). These measurements indicate a detection efficiency of approximately 10% and a response which is flat to within ± 5% over over the entire energy range studied. The efficiency for the detection of neutrons from a Ra-α-Be source (average neutron energy approximately 5 MeV) was found to be 6.5%. The efficiency was observed to decrease for neutron energies below about 0.1 MeV by measuring the yield from the V^{51}(p,n) reaction. The efficiency for the detection of 50-keV neutrons is approximately 4%. The detector was also used to detect neutron thresholds for nuclear ground states and excited states by observing the slow threshold neutrons in the forward direction with a Li^6I scintillator surrounded by a B_4C shield. This "closed geometry" technique appears capable of only slightly less sensitivity than the "open geometry" method and is somewhat superior in energy resolution.

NEUTRON SPECTROMETER FOR STUDY OF (d,n) REACTIONS ON LIGHT NUCLEI. See Abstr. 13846

MEASURING REACTOR NEUTRON SPECTRA WITH THRESHOLD DETECTORS. See Abstr. 13908

Mesons

16821 ON THE G_A/G_V RATIO IN β-DECAY. C.Ihara.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 211-13 (July, 1960)

The composite theory of the pion (Abstr. 3215 of 1961) is to be capable of yielding values for this ratio in excess of unit observed. P.K

16822 ON THE G_A/G_V RATIO IN β-DECAY. II. C.Ihara.
Progr. theor. Phys. (Japan), Vol. 25, No. 2, 301-3 (Feb., 1961)

See preceding abstract. Previous calculations of mesonic corrections using a composite model for the pion, are extended R.J.N.P

16823 PHOTOPRODUCTION OF NEUTRAL VECTOR MESONS. M.Bassetti.
Nuovo Cimento (Italy), Vol. 20, No. 4, 803-5 (May 16, 1961).

The cross-section for the process $\gamma + p \rightarrow p + X$ is calcul where X is the natural vector meson associated with the Lee a Yang model of weak interactions. C.

16824 COMMENTS ON FERMI'S STATISTICAL THEORY HIGH ENERGY NUCLEAR EVENTS. K.B.Fenton.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 842-3 (May, 1961)

The author points out certain minor errors in Fermi's we known paper (Abstr. 3336 of 1951) and in McConnell's recent r article (Progress in Elementary Particle and Cosmic Ray Phy Vol. 5, p.228). J.

16825 EMPIRICAL FORMULA FOR INTERPOLATING T PRODUCTION OF δ-RAYS BY ELECTRONS.
H.Tellez-Plasencia.
J. Phys. Radium (France), Vol. 22, No. 2, 117-19 (Feb., 1961)
In French.

A simple empirical formula for the interpolation of numb δ-rays produced by electrons is derived:

$$\log(N/\rho) = A + BX + (n/X),$$

where N/ρ represents the number of δ-rays having an energy e or greater than W (keV) produced by the passage of an electro energy E (keV) in a medium of density ρ, $X = \log(2W/E)$ and n given by the expression: $\log n = p + q \log E$ with values of $p = -0.97548$ and $q = -0.03907$. Some curves illustrating the t the above formula and a table of the values of A and n for diffe energies E are also given. J.

16826 ELECTROMAGNETIC INTERACTION OF A NEUT VECTOR MESON.
I.Yu.Kobzarev, Yu.B.Okun' and I.Ya.Pomeranchuk.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 495-8 (Aug.,
In Russian.

The interaction between a neutral vector meson and photo considered. The two particles can change into each other. In connection the problem of diagonalization of the Green's functi for a vector meson and photon is examined. [English translatio Soviet Physics–JETP (USA)].

16827 ON THE NEUTRAL DECAY PRODUCTS OF MUON P.Vértes.
Acta phys. Hungar., Vol. 12, No. 3, 249-53 (1960).

Possible tests of the identity of the neutrinos from beta d and muon decay. J.E

16828 TO THE QUESTION OF ELECTRON ANGULAR DISTRIBUTION AT μ-MESON DECAY.
M.Friml and A.Mazur.
Czech. J. Phys., Vol. 11, No. 8, 554-8 (1961).

The measurement is described of the angular distribution electrons at the decay of μ-mesons in a longitudinal magnetic The results indicate that electrons are preferentially emitted only in the direction parallel to the spin orientation of μ-meso but also in the antiparallel direction, in disagreement with the angular distribution predicted by theory.

829 INTERNAL BREMSSTRAHLUNG AND ELECTRO-MAGNETIC CORRECTIONS TO μ—e DECAY.
Zuznetsov.
ksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1721-6 (Dec., 1960).
ssian.
Electromagnetic corrections to the electron polarization and
e electron and μ—e decay are derived and the polarization and
ar distribution of γ quanta in internal bremsstrahlung are
mined. Electromagnetic corrections to the spectrum, to the
ar distribution and to the electron polarization in μ—e decay
omputed in the low-energy region. [English translation in:
t Physics—JETP (USA), Vol. 12, No. 6, 1202-5 (June, 1961)].

830 μ^- MESON DECAY FROM THE K ORBIT.
M.V.Terent'ev.
ksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1734-6 (Dec., 1960).
ssian.
The decay $\mu^- \rightarrow e + \nu + \bar{\nu}$ is considered theoretically for the
when the meson is in a bound state in the K orbit of the atom.
spectra of the decay electrons are calculated for several
ents and the μ^- meson lifetime is determined as a function of Z.
calculations are carried out with an accuracy up to linear terms
e parameter Z/137. [English translation in: Soviet Physics—
(USA), Vol. 12, No. 6, 1211-12 (June, 1961)].

831 SOME ENERGY RELATIONS OBTAINED WITH ALLOWANCE FOR PARITY NONCONSERVATION IN μ—e
AY. V.S.Berezinskii and G.T.Zatsepin.
ksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1847-9 (Dec.,
. In Russian.
The portion of the energy transferred to the electrons in μ—e
-μ—e decay is calculated with allowance for the nonconserva-
f parity in μ—e decay. [English translation in: Soviet Physics—
(USA), Vol. 12, No. 6, 1288-9 (June, 1961)].

832 ASYMMETRY IN THE ANGULAR DISTRIBUTION OF ELECTRONS FROM μ—e DECAY IN MAGNETIC
DS UP TO 35 000 OERSTED.
li-Zade, I.I.Gurevich and B.A.Nikol'skii.
ksper. teor. Fiz. (USSR), Vol. 40, No. 2, 452-6 (Feb., 1961).
ssian.
μ—e decays were observed in nuclear emulsions placed in a
etic field, the purpose of the experiment being to study the
metry in the angular distribution of electrons from μ—e
s in a magnetic field. It was found that longitudinal magnetic
up to 20 000-30 000 Oe do not completely remove the depolar-
action of the medium (emulsion) on the μ-meson. [English
lation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 313-16
, 1961)].

833 MAGNETIC MOMENT OF POSITIVE AND NEGATIVE MUONS.
Hutchinson, J.Menes, G.Shapiro, A.M.Patlach and S.Penman.
Rev. Letters (USA), Vol. 7, No. 4, 129-33 (Aug. 15, 1961).
Experimental refinements were made which give a greater
stical accuracy in the values of the magnetic moment of
ive and (bound) negative muons in various materials. The
ections to be applied to the measurements for negative muons
iscussed and it is concluded that the two values agree to
1 pt in 10^4, the ratio f_{μ}/f_p being 3.18334 ± 0.00005.
V.M.Rout

834 ANGULAR DISTRIBUTIONS OF HIGH-ENERGY MUONS IN THE ATMOSPHERE AND THEIR PRODUCTION
HANISM. G.T.Zatsepin and V.A.Kuz'min.
ksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1677-85 (Dec., 1960).
ssian.
The kinetic equation for μ mesons in the atmosphere in which
ecay and energy losses are taken into account is solved. The
lar distributions of 10^{11} to 10^{14} eV μ-mesons in the atmosphere
omputed for two possible production mechanisms: $\pi \rightarrow \mu + \nu$
$\rightarrow \mu + \nu$ decays. The results indicate that in the energy range
^{11} to 5×10^{12} eV the μ-meson angular distributions depend
ficantly on the mechanism of their production. [English
lation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1171-7
, 1961)].

16835 BREMSSTRAHLUNG IN MUON—PROTON SCATTERING EXPERIMENTS.
J.M.Abillon and P.Kessler.
J. Phys. Radium (France), Vol. 22, No. 8-9, 521-4 (Aug.-Sept., 1961).
In French.
In connection with muon—proton scattering experiments in a region where the momentum transfer is several hundred MeV, the contribution of bremsstrahlung to the scattering cross-section has been calculated by the method of quasi-real processes. The result has to be combined with the Schwinger correction, which includes both virtual radiative effects and emission of real photons with very low energy. The total radiative correction is obtained as a function of initial energy of the muon, scattering angle, and resolution width for the final energy. A numerical application is given for an initial energy of 2 GeV and different values of the scattering angle and the resolution width.

16836 INVESTIGATION OF μ^+-MESON DEPOLARIZATION IN NUCLEAR EMULSIONS. Yu.M.Ivanov and A.I.Fesenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1492-6 (Dec., 1960).
In Russian.
The influence of the relative AgBr content in nuclear emulsions on the magnitude of the asymmetry coefficient for the $\mu^+ \rightarrow e^+$ decay was studied experimentally. Values of the μ^+-meson depolarization were obtained separately for AgBr and for gelatin. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1037-40 (June, 1961)].

OBSERVABLE EFFECTS OF THE SPIN DEPENDENCE OF MUON ABSORPTION. See Abstr. 17299

MUON DISAPPEARANCE RATES IN C, Mg, Al, Si AND P. See Abstr. 17300

16837 THE FORM-FACTOR OF THE PION AND THE STRUCTURE OF NUCLEONS. H.Salecker.
Z. Phys. (Germany), Vol. 164, No. 4, 463-82 (1961). In German.
Measurements of electron—proton scattering at Stanford showed that the electric and magnetic form-factors are not equal. The isotopic vector parts of the form factors G_e^v and G_m^v are therefore recalculated with unsubtracted dispersion relations in the 2π approximation. For the isotopic scalar parts are used $G_e^s(s) \cong G_e^v(s)$ and $G_m^s(s) \cong 0$, which is known to be valid for moderate energy-momentum transfers. A simple closed expression is obtained for the electromagnetic form-factor of the pion F_π in terms of the scattering length a_1 and the effective range r_1 of the π—π scattering in the state $L = T = 1$. a_1 is known roughly from pion production by pions. With this value and a suitable r_1, F_π is resonant in the region of time-like energy-momentum transfer; and the pion r.m.s. radius becomes $r_\pi^2 = (0.82 \times 10^{-13}\ \text{cm})^2$. The calculated anomalous magnetic moment and the electric and the magnetic r.m.s. radii of the proton are then within 10% of experimental values, and the electric charge within 30%. The proton form-factors are different from each other and, up to an energy-momentum transfer of $s = -q^2/m_\pi^2 = 23$, within the experimental error of the new measurements. The deviations for higher values of the energy-momentum transfer may be explained in terms of the isotopic scalar parts of the form factors. In this case the electric form-factor of the neutron differs from zero in that region and the magnetic form-factors of the proton and neutron are no longer equal. For comparison with other experiments, the $\pi^+ - \pi^-$ cross-section is also calculated, neglecting states other than $L = T = 1$. With this assumption, the π—π cross-section is resonant for low energy-momentum transfer.

16838 RADIATIVE CORRECTIONS TO $\pi^- \rightarrow \pi^0 + e^- + \bar{\nu}$ DECAY.
G.Da.Prato and G.Putzolu.
Nuovo Cimento (Italy), Vol. 21, No. 3, 541-9 (Aug. 1, 1961).

16839 INVESTIGATION OF THE SPECTRUM AND ASYMMETRY OF ELECTRONS FROM THE π—μ—e DECAY IN NUCLEAR EMULSION.
A.O.Vaĭsenberg, V.A.Smirnitskiĭ and É.D.Kolganova.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1042-9 (April, 1961).
In Russian.
The energy spectrum and spatial asymmetry of positrons from the π^+—μ—e decay in nuclear emulsion placed in a magnetic field were measured. The values obtained for the Michel parameter

$\rho = 0.66 \pm 0.07$ and the asymmetry parameter $\delta = 0.63 \pm 0.63$ are in agreement with the theory of the two-component neutrino. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 734-9 (Oct., 1961)].

16840 EVIDENCE FOR A T = 0 THREE-PION RESONANCE. B.C.Maglić, L.W.Alvarez, A.H.Rosenfeld and M.L.Stevenson.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 178-82 (Sept. 1, 1961).

The authors examined the effective mass distribution of triplets of pions in the reaction $\bar{p} + p \rightarrow \pi^+ + \pi^+ + \pi^- + \pi^- + \pi^0$ to detect any three pion decay mode. A very sharp resonance in the three body effective mass was detected at 787 MeV with a half-width at half maximum of less than 15 MeV. From the charge distribution of the outgoing pions, it is shown that the isotopic spin of the resonance is zero. By using a Dalitz plot, the authors conclude that this new meson probably has a vector character.
C.Wilkin

16841 ON THE FINAL-STATE INTERACTION IN SINGLE-PION PRODUCTION PROCESSES. A.Krzywicki.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 305-11 (1961).

In order to explain the difference between the experimental cross-sections for the processes $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ and $\pi^- + p \rightarrow \pi^- + \pi^0 + p$, Selleri et al. proposed the existence of a final-state interaction. In this paper, the author describes a scheme of calculation to investigate this interaction quantitatively. Because of the complexity of the resultant graph, many simplifying assumptions are made. A formula for the transition probability for the process is obtained in terms of the (33) pion—nucleon phase shift, which is assumed to dominate the products of the final-state interaction. The author claims that this leads to a differential cross-section distribution, which, although it fails at lower energies, is reasonable for energies close to 1 BeV and above.
C.Wilkin

16842 SOME REMARKS ON LOW ENERGY PION PHENOMENA. J.K.Walker.
Nuovo Cimento (Italy), Vol. 21, No. 3, 577-80 (Aug. 1, 1961).

By reanalysing the experimental photoproduction data according to better theoretical prescriptions there emerge certain small but not insignificant discrepancies. If the cross-sections for the photoproduction process $\gamma + p \rightarrow n + \pi^+$ is plotted, there appears to be a small hump in the curve not accounted for by the theory of Chew—Goldberger—Low—Nambu—Robinson. The author concludes that more experimental data is needed to verify or otherwise this phenomenon.
J.H.Gunn

16843 PHOTOPRODUCTION OF π^0 IN THE COULOMB FIELD OF THE ELECTRON. P.G.Sona.
Nuovo Cimento (Italy), Vol. 21, No. 3, 416-21 (Aug. 1, 1961).

Parallel to the process, studied by Primakoff (Abstr. 4754 of 1951), of photoproduction of π^0 in the Coulomb field of the nucleus, there exists another photoproduction process of π^0 in the Coulomb field of the electron. The total cross-section is of the same order as that of the Primakoff process, divided by Z^2. A formula is given for the angular distribution in the c.m. system. The possibility is considered of utilizing this process to determine the mean life of π^0.

16844 THE PRODUCTION AND PROPERTIES OF MESONS AT HIGH ENERGIES.
F.A.Brisbout, C.Gauld, J.Lehane, C.B.A.McCusker, J.Malos, K.Nishikawa and L.G.van Loon.
Nuclear Phys. (Internat.), Vol. 26, No. 4, 634-48 (Sept., 1961).

Results from a 10.1 stack of Ilford K5 emulsion flown to 38.4 km are presented. It is shown that the transverse momentum spectrum of the secondary particles of jets has two peaks at about 0.4 and 2.0 GeV/c respectively, and possibly a third peak at about 8 GeV/c; that the interaction cross-section of secondary pions is considerably smaller than the geometric value; that the interactions they produce in emulsions have a lower average multiplicity than proton-produced interactions in the same energy range; and that the number of particles per interaction close to the forward direction is less than that expected from extrapolation from slightly greater angles. The results are compared with those of other experiments and their meaning discussed.

16845 DISPERSION RELATIONS FOR PHOTOPRODUCT OF π^0-MESONS ON DEUTERONS. V.Šachl.
Nuclear Phys. (Interant.), Vol. 26, No. 4, 681-92 (Sept., 1961

The dispersion relations for the process of photoproduct neutral mesons on deuterons are derived with the aid of the approximations. The unobservable region begins with the st free proton and neutron and contains no other poles. The ca tions including the recoil in the Breit system are carried ou two-nucleon approximation and are specialized for the value momentum $\frac{1}{4}\mu^2 M/(M + \mu)$, where they are valid up to a maxim photon energy of 236 MeV. The derivation of the results wit the spin-flip part is given for the case of deuterons perpendi polarized to the direction of propagation of mesons and photo

16846 ANOMALY IN MESON PRODUCTION IN p + d CO N.E.Booth, A.Abashian and K.M.Crowe.
Phys. Rev. Letters (USA), Vol. 7, No. 1, 35-9 (July 1, 1961).

A previous experiment (Abstr. 28213 of 1960) was repea better momentum resolution. A description is given of the n experimental arrangement. Momentum spectra of He^3 and H displayed, and are combined to give the I = 0 part of the He^3 This shows the peak at about 1400 MeV/c. An explanation is in terms of a strong S-wave π—π interaction. Using the Che Mandelstam method, a fit is obtained with a scattering length 2.8 pion Compton wavelengths. The peak occurs at a mass v about 300 MeV and has a width of about 25 MeV, giving a life ~ the interaction time. A.A

16847 DOUBLE MESON PRODUCTION IN PROTON—DEUTERON COLLISIONS.
N.E.Booth, A.Abashian and K.M.Crowe.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 393-4 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Improved measurements on the He^3 and H^3 spectra in $p + d \rightarrow He^3 + 2\pi$ $p + d \rightarrow H^3 + 2\pi$ at 740 MeV are reported. The anomaly in the (Abstr. 20213 of 1960) has no counterpart in the latter, indica that a 2π state with T = 0 is involved. R.J.N.I

16848 PION—PION INTERACTIONS AND PION PRODU BRANCHING RATIOS AT THE THIRD RESONAN E.O.Salant, E.Pickup, D.K.Robinson and B.A.Munir.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 435-6 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Bubble ch measurements of the branching ratio

$$(\pi^- + p \rightarrow \pi^- + \pi^+ + n)/(\pi^- + p \rightarrow \pi^- + \pi^0 + p)$$

in the range 0.8-1 GeV suggest that the production of 2π state T = 0 and T = 1 is roughly equal and constant. R.J.N.I

16849 PRODUCTION OF CHARGED MESONS BY 290 M MESONS ON HYDROGEN.
Yu.A.Batusov, S.A.Bunyatov, V.M.Sidorov and V.A.Yarba.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 460-3 (Feb., 19 In Russian.

The $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ reaction is investigated. The e mental data are compared with the theoretical calculations. Abstr. 20214 of 1960. [English translation in: Soviet Physic JETP (USA), Vol. 13, No. 2, 320-2 (Aug., 1961)].

16850 PHOTOPRODUCTION OF PIONS ON PIONS. L.D.Solov'ev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 597-604 (Feb., In Russian.

An exact solution is found for the equation that describe photoproduction of pions on pions at low energies. The condi for a unique solution is formulated. The solution is determi the high-energy singularities of the amplitude. It has a reso character if resonance occurs in the scattering of pions on p a state with J = I = 1. [English translation in: Soviet Physic JETP (USA), Vol. 13, No. 2, 418-22 (Aug., 1961)].

16851 COMPLETE SET OF EXPERIMENTS FOR DETE MINATION OF RELATIONS BETWEEN THE AMPLITUDES FOR PION PRODUCTION BY NUCLEONS IN VARIOUS ISOTOPIC SPIN STATES. K.S.Marish and L.M.So Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 605-12 (Feb., In Russian.

The number of experiments so far performed with nucle

)0 MeV energy region is not sufficient to determine all the ons among the amplitudes. One of the experiments discussed rovide a sensitive test of the validity of the resonance theory n production by nucleons. [English translation in: Soviet cs—JETP (USA), Vol. 13, No. 2, 423-7 (Aug., 1961)].

852 DOUBLE DISPERSION RELATIONS AND PHOTOPRODUCTION OF PIONS. N.F.Nelipa.
sper. teor. Fiz. (USSR), Vol. 40, No. 4, 1085-92 (April, 1961).
sian.
set of integral equations is obtained for the partial photo-ction amplitudes. It differs from that previously found in that s the partial amplitudes for scattering of pions on nucleons it ontains the partial amplitudes for nucleon pair annihilation into ons and the photoproduction of pions on pions. These ampli- are related to the partial amplitudes for scattering of pions by [English translation in: Soviet Physics—JETP (USA), Vol. 13, 766-70 (Oct., 1961)].

853 INVESTIGATION OF THRESHOLD ANOMALIES IN THE CROSS-SECTIONS FOR COMPTON SCATTERING AND OPRODUCTION OF π^0-MESONS. G.K.Ustinova.
sper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 583-7 (Aug., 1961).
sian.
ompton scattering on protons near the threshold for π^0 and eson production and photoproduction of π^0-mesons near the eson threshold are examined phenomenologically. A peculiar f energy dependence of the cross-sections for elastic γ—p ring and photoproduction of neutral mesons is obtained if nt is made for predominance of production of mesons in the e near the threshold. Analytic expressions are derived for the nd differential cross-sections for the Compton effect and π^0-roduction near the thresholds. Some numerical estimations of omalies are presented. [English translation in: Soviet cs—JETP (USA)].

854 INVERSE PHOTOPRODUCTION REACTION $\pi^- + p \rightarrow \gamma + n$ IN FLIGHT.
ti, P.Hillman, W.C.Middelkoop, T.Yamagata and E.Zavattini.
Rev. Letters (USA), Vol. 6, No. 12, 706-8 (June 15, 1961).
he cross-section at a pion energy of 72 MeV is measured to ± 7 μb/ster. From detailed balancing the photoproduction -section of pions on neutrons is calculated and compared with . A deviation is found and is thought to be due to a strong e $\pi - \pi$ resonance. J.E.Paton

855 EFFECT OF NUCLEON BINDING ON THE SHAPES OF PION ENERGY SPECTRA.
ovchenko, G.Gel'fer, A.S.Kuznetsov, M.G.Meshcheryakov and atkovskii.
sper. teor. Fiz. (USSR), Vol. 39, No. 6, 1557-70 (Dec., 1960).
sian.
. comparative investigation of the π^+ and π^- spectra produced 4 MeV protons in free p—p collisions, and in p—p and p—n ions in deuterons and carbon nuclei, was carried out with a etic spectrometer. The observed difference between the s of pion spectra from deuterium and carbon is due to (a) a degree of nucleon-pair correlation in carbon than in ons, (b) differences in the nucleon momentum distribution,) secondary pion—nucleon interactions in carbon. The ratios 79 : 0.40 were obtained for the differential cross-sections production on free protons and on protons in D and C at in the c.m. system of the two colliding nucleons. The π^- from D and C per neutron of the target nucleus are approxi-y equal. At the given angle the ratio of π^+ to π^- yield from C is 10.3 ± 1.3 and 6.0 ± 0.8, respectively. The difference ributed to an appreciable contribution from the secondary nge interaction $\pi^0 + n \rightarrow \pi^- + p$ to the π^- yield from carbon. sh translation in: Soviet Physics—JETP (USA), Vol. 12, 1084-92 (June, 1961)].

856 SOME REMARKS ON THE FERMI—YANG MODEL. Y.Ataka.
. theor. Phys. (Japan), Vol. 24, No. 1, 218-20 (July, 1960).
he pion—pion and K—nucleon potentials are discussed on the of this model following the methods of the author's previous (Abstr. 20203 of 1960) and the results obtained are not sistent with experiment. P.K.Kabir

16857 PION—PION INTERACTION AND HIGH ENERGY p + d COLLISIONS. J.G.Taylor.
Phys. Rev. Letters (USA), Vol. 6, No. 5, 237-8 (March 1, 1961).
Tubis and Uretsky (Abstr. 497 of 1961) suggested that if a final-state P-wave pion—pion interactions, described in the scattering length approximation, is added to the statistical model of Abashian et al (Abstr. 20213 of 1960), a P-wave scattering length of magnitude 2.5 explains the anomaly in meson production in p + d collisions. The author claims that this value is too large; evidence is put forward from the equations relating the three scattering lengths as derived from crossing symmetry, and from the experimental data on the asymmetry of the pion spectrum in τ-decay. J.H.Gunn

16858 A DRESSED PARTICLE ANALYSIS OF THE $\pi + d \rightleftharpoons 2N$ REACTION. M.A.Braun.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1179-84 (April, 1961).
In Russian.
This reaction is treated by a nonrelativistic meson theory of the πN interaction in the P state. Dressed particle techniques are used to express the amplitude for this process in terms of the coupling constant and the P-wave phase shifts for πN scattering. The energy and angle dependence of the calculated cross-sections are in qualitative agreement with experiment. The maximum difference between the theoretical and observed cross-sections for angles far from 90° and energies that are not too high is 30%. For angles close to 90° and energies much higher than resonant the calculated cross-section becomes as much as two times as large as the experimentally observed one. Improvement of the results requires including the S state in the πN interaction, as well as high nucleon velocities. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 828-31 (Oct., 1961)].

16859 PION INTERACTION IN FERMI STATISTICAL THEORY. V.S.Barashenkov.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 471-4 (1961).
By assuming a $\pi\pi$-resonant interaction, the energy spectra of pions and nucleons generated in inelastic NN collisions at E = 9 BeV were calculated. The results of the calculation are compared with experiment.

16860 SOME ISOTOPIC RELATIONS FOR REACTIONS OF THE TYPE $\pi N \rightarrow \pi\pi N$. V.N.Strel'tsov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1140-2 (April, 1961).
In Russian.
Isotopic relations are utilized in an analysis of experimental data for these reaction types from the point of view of resonant $\pi\pi$ interactions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 802-3 (Oct., 1961)].

16861 THE MATRIX ELEMENT OF THE REACTION $\pi + N \rightarrow \pi + \pi + N$ AT LOW ENERGIES.
P.I.Zav'yalov and V.P.Pavlov.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 79-82 (July 1, 1961).
In Russian.
Taking into account the nearest singularities of the S-matrix a method is developed to obtain reaction matrix elements. It leads to formulae obtained in previous work by a different argument. [English translation in: Soviet Physics—Doklady (USA)]. F.Herbut

16862 OBSERVATIONS ON THE LONG-RANGE INTERACTIONS OF PIONS. I. PRELIMINARY RESULTS ON THE COHERENT PRODUCTION OF TWO CHARGED PIONS BY PIONS AT 14 GeV. F.Baldassarre, A.Caforio, D.Ferraro, A.Ferilli, M.Merlin, D.H.Perkins, S.Semeraro, J.C.Combe, W.M.Gibson, W.O.Lock, A.Bonetti, M.Di Corato, A.Fedrighini, A.J.Herz, A.E.Sichirollo, L.Tallone, G.Vegni and E.Villar.
Nuovo Cimento (Italy), Vol. 21, No. 3, 459-68 (Aug. 1, 1961).
A stack of nuclear emulsion exposed to 14 GeV/c negative pions was examined by along-the-track scanning. Events with three outgoing relativistic tracks ("tridents") were analysed to see whether their features are consistent with those to be expected for interactions in which an additional pion pair is produced in a process in which the nucleus acts coherently. Examples of such proposed processes are diffraction dissociation and electromagnetic production. Coherent events are characterized by extremely low momentum transfer to the "target" nucleus, and by the absence of any evidence of nuclear excitation. In 168 metres of track, 13 trident events were found in which none of the three outgoing particles is an electron. Five of these satisfy the criteria for diffraction dissociation, and of these one also falls within the

narrower criteria for Coulomb production of a pion pair. From these figures, only upper limits to the cross-sections can be deduced, for other, incoherent, processes can give rise to spurious events. If it is assumed that the one possible case of electromagnetic production is an example of the particular mechanism proposed by Ferretti (Abstr. 8487 of 1961), one can deduce an upper limit of 440 mb to the pion—pion cross-section at the T = 1, J = 1 resonance.

16863 TOTAL CROSS-SECTIONS FOR PIONS ON PROTONS IN THE MOMENTUM RANGE 4.5 TO 10 GeV/c.
G.von Dardel, R.Mermod, P.A.Piroué, M.Vivargent, G.Weber and K.Winter.
Phys. Rev. Letters (USA), Vol. 7, No. 4, 127-9 (Aug. 15, 1961).

Reports a repeated measurement of the total cross-sections for $\pi^{\pm}$ mesons on protons, taking special precautions to reduce uncertainties arising from μ-meson contamination in the beam. The statistical accuracy of the results is about ±1.3% and both cross-sections show a monotonic decrease with increasing momentum, the π^-p cross-section exceeding the π^+p by 7-9%. Therefore, up to 10 GeV/c the cross-sections have not reached either the limiting constant value, which is a condition for Pomeranchuk's theorem, or the equality which is predicted by the theorem. J.D.Dowell

16864 POSSIBLE EXPLANATION OF THE HIGHER PION—NUCLEON AND K^-—p RESONANCES IN TERMS OF INELASTIC THRESHOLDS. J.S.Ball and W.R.Frazer.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 204-7 (Sept. 1, 1961).

It was found that a large rapidly rising but not necessarily sharply peaked inelastic cross-section, of the type that is observed near the higher pion—nucleon resonances, can lead to a sharp sizeable peak in the elastic amplitude. The inelastic contribution to the higher partial waves was calculated using the strip approximation to the Mandelstam representation, assuming that the principal mechanism is the production of the J = 1, T = 1 pion—pion resonance. The higher resonances seem to be implied in approximately the correct positions, although at this stage really quantitative calculations have not been made. The same approximation leads to a resonance in the K^-—p system. C.Wilkin

16865 PARTIAL CROSS-SECTIONS NEAR THE HIGHER RESONANCES. P.Falk-Vairant and G.Valladas.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 362-7 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Measurements of the charge-exchange and π^0 production cross-sections for $\pi^{\pm}$—p collisions between 350 and 1100 MeV are reported and compared with other data. Elastic and inelastic cross-sections for the T = $\frac{1}{2}$ state are deduced; also the (T = $\frac{1}{2}$, T = $\frac{3}{2}$) interference term in the charge-exchange cross-section. Theoretical implications are discussed. R.J.N.Phillips

16866 PION—HYPERON RESONANCES.
M.H.Alston and M.Ferro-Luzzi.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 416-25 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Experimental evidence for a pion—hyperon resonance Y_1^* at 1385 ± 5 MeV, mainly from the reaction $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$, is reviewed and discussed. The half-width is 25 ± 5 MeV; spin, parity and other properties are not well determined. The branching ratio $(Y_1^* \rightarrow \Sigma + \pi)/(Y_1^* \rightarrow \Lambda + \pi)$ seems to be very small. R.J.N.Phillips

16867 PION—PION INTERACTIONS.
J.A.Anderson, V.X.Bang, P.G.Burke, D.D.Carmony and N.Schmitz.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 431-4 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Measurements of the reactions $\pi^{\pm} + p \rightarrow p + \pi^{\pm} + \pi^0$ at 1.03 GeV/c, to give the $\pi^{\pm}$—π^0 cross-section by Chew—Low extrapolation, are described. The results are consistent with a p-wave π—π resonance around 4.5 m_{π}, or above. R.J.N.Phillips

16868 PERIPHERAL π—π INTERACTIONS BETWEEN HIGH-ENERGY NUCLEONS. P.A.Usik and V.I.Rus'kin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1718-20 (Dec., 1960).
In Russian.

The results of the calculations are compared with the experimental data. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1200-1 (June, 1961)].

16869 THE POLARIZATION OF Λ-HYPERONS PRODUCED FROM LIGHT NUCLEI BY π^--MESONS OF MOMENTUM 2.8 BeV/c. Yu.S.Krestnikov and V.A.Shebanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2, 661-3 (Aug., 196
In Russian.

The authors extend previous work [V.V.Barmin, Yu.S.Kre I.I.Pershin, V.P.Rumyantseva, Ya.Ya.Shalamov and V.A.Sheba Zh. exper. teor. Fiz. (USSR), Vol. 39, No. 5, 1229-32 (Nov., 19 to obtain better statistics. Their results on the asymmetry of production process are still inconclusive, but they do not seem violate parity conservation. [English translation in: Soviet Physics—JETP (USA)]. C.

16870 NEGATIVE PION—PROTON ELASTIC SCATTERI 1.51, 2.01 AND 2.53 Bev/c OUTSIDE THE DIFFR PEAK. K.W.Lai, L.W.Jones and M.L.Perl.
Phys. Rev. Letters (USA), Vol. 7, No. 4, 125-6 (Aug. 15, 1961)

The differential elastic cross-sections for negative pions protons were measured at incident pion momenta of 1.51, 2.01 2.53 BeV/c with emphasis on the angular region outside the diffraction peak. The purpose of the experiment was to exami the behaviour of the large angle differential elastic cross-sec as a function of energy, from the energy of the highest known resonance in the pion—nucleon system into the region where t total cross-sections appear to be approaching an asymptotic v S.J.St-

16871 THE BEHAVIOUR OF THE TOTAL CROSS-SECTI FOR πp-SCATTERING AT HIGH ENERGIES.
Yu.M.Lomsadze, V.I.Lend'el and B.M.Ernst.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1154-5 (Oct.
In Russian.

The Pomeranchuk theorem $\sigma_-(\omega) - \sigma_+(\omega) \rightarrow 0$ (Abstr. 821 1958) is strengthened to $\sigma_-(\omega) - \sigma_+(\omega) \rightarrow \text{const}/\omega$ as $\omega \rightarrow \infty$. [English translation in: Soviet Physics—JETP (USA), Vol. 12, 803 (April, 1961)]. P.K.

16872 EQUATIONS FOR THE SPECTRAL FUNCTIONS O CHARGED PIONS.
Yu.A.Simonov and K.A.Ter-Martirosyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1172-8 (April,
In Russian.

The amplitudes for the scattering of charged pions by cha pions are expressed by means of the Mandelstam representati in terms of the spectral functions. A set of equations is deriv for the one- and two-dimensional spectral functions. One of t methods for obtaining an approximate solution is discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 824-7 (Oct., 1961)].

16873 THE π—π MESON SCATTERING RESONANCE AN ANOMALOUS MAGNETIC MOMENT OF THE μ M
C.Bouchiat and L.Michel.
J. Phys. Radium (France), Vol. 22, No. 2, 121 (Feb., 1961).
In French.

The effect of the J = 1, T = 1 π—π resonance on the magne moment of the μ meson is calculated. It is concluded that the correction term is too small (of the order of 10^{-7}) to be acces to experimental test. S.J.St-L

16874 SOLUTIONS OF THE COUPLED S AND P-WAVE EQUATIONS FOR PION—PION SCATTERING.
B.H.Bransden and J.W.Moffat.
Nuovo Cimento (Italy), Vol. 21, No. 3, 505-18 (Aug. 1, 1961).

A method is presented for solving numerically the coupled P-wave equations for pion—pion scattering derived by Moffat analyticity (Abstr. 3220 of 1961), crossing symmetry and unit on the basis of the Mandelstam representation. It is shown th apart from the pion—pion coupling constant, no further param enter the low-energy theory. For a range of coupling constan taking negative values $|\lambda| \leq 0.45$, solutions exist satisfying c symmetry. These solutions are characterized by the existenc low-energy resonance in the P-wave of which the position and are entirely determined by λ. The corresponding S-wave phas shifts show that scattering in the I = 0 isotopic spin-state is l at low energies.

375 SCATTERING OF π-MESONS ON K-MESONS AT LOW ENERGIES. P.S.Isaev and M.V.Sewerynski.
ar Phys. (Internat.), Vol. 27, No. 1, 148-53 (Sept., 1961).
:xplicit expressions for s- and p-phase shifts of π—K scattering
otained in the effective-range approximation.

376 310 MeV PI^+—p POLARIZATION AND CROSS-SECTION EXPERIMENTS. PHASE SHIFT ANALYSIS.
togers, O.Chamberlain, J.H.Foote, H.M.Steiner, C.Wiegand
.Ypsilantis.
mod. Phys. (USA), Vol. 33, No. 3, 356-61 (July, 1961).
Conference on Strong Interactions Paper, University of
ornia, Dec., 1960 (see Abstr. 10847 of 1961). Experiments and
sis are described. There is a unique Fermi-type phase shift
on if only S, P and D waves are considered. But if small F
shifts are admitted, a second Fermi-type solution appears
ier with others, corresponding to Yang and Minami ambiguities.
R.J.N.Phillips

377 PI—p ELASTIC SCATTERING IN THE ENERGY REGION 500-1500 MeV. B.J.Moyer.
mod. Phys. (USA), Vol. 33, No. 3, 367-73 (July, 1961).
Conference on Strong Interactions Paper, University of
ornia, Dec., 1960 (see Abstr. 10847 of 1961). A survey of data
esented. Analysis of angular distributions in Legendre
omials is described, and possible interpretations are discussed.
R.J.N.Phillips

LOW ENERGY INTEGRAL EQUATIONS FOR π—π
TTERING. See Abstr. 16711

378 RADIATIVE DECAY OF THE NEUTRAL K MESON: $K^0 \to \gamma + \gamma$. J.Dreitlein and H.Primakoff.
. Rev. (USA), Vol. 124, No. 1, 268-73 (Oct. 1, 1961).
The consequences of the particle mixture theory of the neutral
son are investigated for the rare radiative decay mode:
$\gamma + \gamma$. The two-phonon decay rates of the K_1^0, K_2^0 mesons are
nated as $\sim 1.3 \times 10^5$ sec^{-1} (Cabibbo and Ferrari) and $\sim$
$\times 10^5/(g_{\Sigma nK}^2/4\pi)\}$ sec$^{-1} \cong 10^5$ sec^{-1}. It is shown that a time-
ident net circular polarization of each of the two photons
ts from the interference between the K_1^0 and K_2^0 channels
ng the 2γ state. The correlated linear polarizations of the two
ns also exhibit a similar time-dependent behaviour. The
bility of experimental detection of the effects discussed, from
the sign as well as the magnitude of the K_1^0, K_2^0 mass differ-
can be determined, is very briefly explored.

379 ON THE RADIATIVE DECAY MODE $K^+ \to \pi^+ + \pi^0 + \gamma$. D.Monti, G.Quareni and A.Quareni Vignudelli.
o Cimento (Italy), Vol. 21, No. 3, 550-4 (Aug. 1, 1961).
A decay mode: $K^+ \to \pi^+ + \pi^0 + \gamma$ was observed. Up to now,
s the third event supporting such decay mode. The π^+ energy
$\pm$ 1.5 MeV. Taking into account the available experimental
the branching ratio, which corresponds to the energy interval
30) MeV of the positive pion, results were found to be 8×10^{-4}
itive decays per K^+-decay. A part from fluctuations, the
ioned value might be underestimated by a factor two. In
r to justify the experimental branching ratio a direct emission
is needed, in addition to the bremstrahlung term, which
would account for a ratio of 1.6×10^{-4}.

380 SOME ANALYTIC PROPERTIES OF A DECAY AMPLITUDE WITH FINAL STATE INTERACTIONS.
IE VERTEX DIAGRAMS IN $K \to 3\pi$ DECAY.
rton and C.Kacser.
o Cimento (Italy), Vol. 21, No. 4, 593-604 (Aug. 16, 1961).
The simplest vertex-type diagrams for $K \to 3\pi$ decay contain an
nal double pion line; when the total rest-mass parameter λ of
line is taken as discrete, the amplitude possesses on the
ical sheet an anomalous branch point above the normal one,
ect to the condition

$$(M^2 - \mu^2)/2 < \lambda^2 < (M - \mu)^2,$$

M the kaon and μ the pion mass. On integrating over λ^2 this
larity is eliminated. In order to understand the amplitude
, it must be considered temporarily as a function of two complex
ibles, in which a double dispersion representation is found to
The spectral functions are examined in semi-closed form to
plify these statements, and to give a perturbation-theory
illustration of some of the popular approximations in calculations on this decay.

16881 DECAY MODES OF K*.
M.A.B.Bég, P.C.DeCelles and R.B.Marr.
Phys. Rev. (USA), Vol. 124, No. 2, 622-3 (Oct. 15, 1961).
Using strong selection rules alone, the principal decay channels for the $K\pi$ resonance (K*) are enumerated. It is pointed out that the reactions $K^* \to K + \gamma(e^+ + e^-)$ and $K^* \to K + 2\pi$ determine the spin on qualitative grounds alone. A plausible estimate is made of the radiative width $[\Gamma(K + \gamma) \sim 10^{-2}\Gamma(K + \pi)]$. Experiments are suggested which may shed some light on the electromagnetic coupling of the K*K system.

16882 K_{e3} DECAY AS A TEST OF UNIVERSAL V—A LEPTON. M.Bolsterli and D.A.Geffen.
M.Bolsterli and D.A.Geffen.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 203-4 (Sept. 1, 1961).
It is shown that the experimental spectrum of electrons from Ke_3 decay can provide a direct test of universal vector-axial vector lepton coupling, independent of the K—π form factor.
C.Wilkin

16883 K_2^0 DECAYS AND INTERACTIONS.
D.Luers, I.S.Mittra, W.J.Willis and S.S.Yamamoto.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 255-9 (Sept. 15, 1961).
Some results bearing on the structure of the strangeness-changing weak interaction in the decay of the K_2^0 meson are reported. The experiment, with low-energy K_2^0 mesons in the BNL 20 in. hydrogen bubble chamber, also gives information concerning K^0—p and $\overline{K}^0$—p interactions. S.J.St-Lorant

16884 THE FORM FACTOR FOR $K_{\mu 3}$ AND K_{e3} DECAY. Ya.B.Zel'dovich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1766-9 (Dec., 1960).
In Russian.
A hypothesis is proposed according to which the K-meson and pion 4-velocities enter symmetrically the expression for the matrix element of the interaction between K mesons or pions and the lepton current (on which $K_{\mu 3}$ and K_{e3} decay depend). [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1232-4 (June, 1961)].

16885 THE τ^+-DECAY AND THE BOSON ISOBAR WITH I = 2 OF THE SAKATA MODEL.
S.Sawada, T.Ueda and M.Yonezawa.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 868-70 (May, 1961).
The 3π-decay process of kaons is assumed to consist of a cascade decay through the boson isobar with I = 2 of the Sakata model. The isobar is treated as a metastable particle with a mass distribution under the assumption of universality of weak interaction. The π^+ energy spectra are calculated. The agreement with experiment is claimed to be fairly satisfactory. F.Herbut

16886 METHOD FOR DETERMINING THE SPIN OF THE K—π RESONANCE. D.O.Caldwell.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 259-61 (Sept. 15, 1961).
It is suggested that the K* spin assignment can be checked by observing the reactions

$$K + He^4 \to K^* + He^4$$
$$K + He^4 \to K^* + He^4 + \pi$$

and looking at the K* decay distribution under certain circumstances.
S.J.St-Lorant

16887 K_1^0—K_2^0 MASS DIFFERENCE.
V.Barger and E.Kazes.
Phys. Rev. (USA), Vol. 124, No. 1, 279-80 (Oct. 1, 1961).
To account for the K_1^0—K_2^0 mass difference a direct K_1^0—2π interaction is introduced which gives $\tau(K_1^0)[m(K_1^0)-m(K_2^0)]$ in terms of the I = 0, s-wave pion—pion scattering phase shifts.

16888 ON THE DETERMINATION OF THE SIGN OF THE MASS DIFFERENCE OF K_1^0 AND K_2^0 MESONS.
S.G.Matinyan.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1747-55 (Dec., 1960).
In Russian.
The experiment proposed by Kobzarev and Okun (Abstr. 3230 of 1961) for determining the sign of the mass difference Δm of K_1^0 and K_2^0 mesons is discussed with a view to taking into account the finite thickness of the plates through which the K_2^0-meson beam passes.

A modification of this experiment which should lead to an increased K_1^0-meson yield from the plates is suggested. Other methods of determining the sign of Δm are also discussed. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1219-24 (June, 1961)].

16889 PROGRESS REPORT ON AN EXPERIMENT TO STUDY LAMBDA^0–K^0 PRODUCTION AT SIGMA–K THRESHOLD. F.Eisler, P.Franzini, J.M.Gaillard, A.Garfinkel, J.Keren, R.Plano, A.Prodell and M.Schwartz.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 436-8 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). A Brookhaven experiment to detect anomalies in $\pi^- + p \rightarrow \Lambda^0 + K^0$ production at the $\Sigma + K$ threshold is described. Preliminary data show that angular momenta $L > 1$ occur in the $\Lambda + K$ channel, complicating any interpretation. R.J.N.Phillips

16890 THE CUSP IN LAMBDA–K PRODUCTION AT SIGMA–K THRESHOLD. S.E.Wolf, N.Schmitz, L.J.Lloyd, W.Laskar, F.S.Crawford, Jr, J.Sutton, J.A.Anderson and G.Alexander.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 439-47 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Measurements are reported of $\pi^- + p \rightarrow \Lambda^0 + K^0$, $\Sigma^0 + K^0$ and $\Sigma^- + K^+$ at and near the thresholds for the last two channels, using the Berkeley 72 in. hydrogen bubble-chamber and a single incident pion momentum. The $(\Sigma^- + K^+) - (\Sigma^0 + K^0)$ mass difference is determined incidentally. There is evidence of cusps in $\Lambda + K$ production, but the statistics are not yet adequate. The presence of angular momenta $L > 1$ and a possible Minami ambiguity will make interpretation difficult, but this may be helped if a connection with the third resonance in π–N scattering can be established. R.J.N.Phillips

16891 DOUBLE PION PRODUCTION IN K–N COLLISIONS. C.H.Chan.
Nuovo Cimento (Italy), Vol. 21, No. 3, 500-4 (Aug. 1, 1961).

Recent experiments showed a fair probability of single pion production in high energy K–N collisions. This process has been calculated (Abstr. 5776, 7283, 9767 of 1961) in the peripheral interaction with a K' isobar model and found in good agreement with experiments. Here the calculation of double pion production in a similar model is reported, particularly for the process:

$$K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$$

since this is easily detected experimentally.

16892 AN ISOBARIC STATE K* IN K–π SYSTEM AND $p + \bar{p} \rightarrow K + K + \pi + \pi$ PROCESS. S.Minami.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 861-3 (May, 1961).

The author considers the reaction $p + \bar{p} \rightarrow K + \bar{K} + \pi + \pi$ under the assumption that the reaction mainly takes place through the process $p + \bar{p} \rightarrow K^* + K^* \rightarrow K + \bar{K} + \pi + \pi$. The p–$\bar{p}$ system can be described in terms of the reaction amplitudes of $I = 1$ and $I = 0$. The branching ratios assuming $I_{K^*} = \frac{1}{2}$ are estimated for the case in which only the $I = 1$ state reacts strongly, and these are equal to the case in which only the $I = 0$ state reacts strongly. The corresponding branching ratios are also given for $I_{K^*} = \frac{3}{2}$ in the two cases of $I = 1$ or $I = 0$ strongly reacting. J.H.Gunn

16893 Y* EFFECTS IN THE REACTION $K^- + p \rightarrow \Sigma + \pi$ ON COMPLEX NUCLEI. Y.Eisemberg, G.Yekutieli, P.Abrahamson and D.Kessler.
Nuovo Cimento (Italy), Vol. 21, No. 3, 563-6 (Aug., 1961).

The events were detected in a nuclear emulsion stack exposed to the 300 MeV/c K^- beam at Berkeley. The invariant mass and total energy distributions are plotted for captures both at rest and in flight. Analysis of the former is consistent with $\frac{1}{3}$ of the captures preceeding via the Y* channel. The captures on flight also show both the direct process and the intermediate Y* process. It appears that the mass of the Y^{*0} is 10-15 MeV greater than the mass of the $Y^{*\pm}$. A.Ashmore

16894 K MESON–NUCLEON INTERACTION AT HIGH ENERGY. S.Minami.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 863-5 (May, 1961).

Since the existence of new isobaric states K* and Y* seems to be confirmed by recent experiments, the author thinks it probable that there should be an isobaric state $\bar{K}^*$ in the K–Π system if $\bar{K}$–Π interaction is invariant under the transformation of charge conjugation. The author discusses what kind of prediction in collision or K–N collision at high energy may be made by tal into account the effects of K* (or $\bar{K}^*$). J.

16895 TOTAL CROSS-SECTION MEASUREMENTS OF K AND K^+–n INTERACTIONS IN THE MOMENTUM REGION 0.77 TO 2.83 BeV/c.
V.Cook, D.Keefe, L.T.Kerth, P.G.Murphy, W.A.Wenzel and T
Phys. Rev. Letters (USA), Vol. 7, No. 5, 182-4 (Sept. 1, 1961)

The total cross-sections for K^+-mesons on protons and neutrons, using hydrogen and deuterium targets 4 ft long, we measured in the momentum interval 0.77 to 2.83 BeV/c with object of clarifying some disagreements among the measurer other groups in the region of a few BeV/c. K^+-mesons in the were selected by two gas Cherenkov counters in coincidence special precautions were taken to avoid accidental coincidenc caused by the high proton flux. Corrections, mostly amounti a few tenths of a millibarn, were included for decay-in-flight differences between target full and target empty runs, nuclea scattering, multiple scattering and the Glauber screening co in the deuteron. The statistical errors in the resulting meas ments are in the region of a few percent and, after a rise of 5 mb from the lowest momentum measured, the cross-sectio and σ_n appear to remain approximately equal and constant at 18 mb in the momentum interval 1-3 BeV/c, implying that th and $T = 1$ interactions are of approximately equal strength. measurements link up well with those of the M.I.T. group at momenta and the Dubna group at higher momenta. J.D.

16896 K^+–p INTERACTION AT 455 MeV. T.F.Stubbs, H.Bradner, W.Chinowsky, G.Goldhab S.Goldhaber, W.Slater, D.M.Stork and H.K.Ticho.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 188-92 (Sept. 1, 196

The 15 in. Berkeley hydrogen bubble chamber was expos a separated K^+-beam of 810 MeV/c (T_K = 455 MeV), which c tained 10% of light particles. Elastic collisions of the K-mes were distinguished from inelastic by kinematical criteria. Identifiable π^+–p elastic interactions were used to estimate number of such events in the angular region in which they we kinematically indistinguishable from K^+–p elastic scattering 1330 elastic K^+–p events yielded an elastic cross-section of 13.0 ± 0.7 mb whilst the inelastic cross-section was found to 1.0 ± 0.2 mb. The elastic angular distribution is almost iso and was analysed in terms of s- and p-waves. Three possibl of phase-shifts, $A^\pm$, $B^\pm$, and $C^\pm$, were obtained which fit the where the "±" refers to the sign of the dominant phase-shift ($s_{1/2}$, $p_{1/2}$, and $p_{3/2}$ respectively). The small-angle behaviour to favour the "–" solutions. The inelastic events were analy into different reactions and the branching ratios are discusse J.D.

16897 K–NUCLEON INTERACTION. L.T.Kerth.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 389-92 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Three exp are reported: K^-–nucleon total cross-sections in the regions 0.6-1.1 GeV/c and 1-4 GeV/c, and K^+–nucleon total cross-s from 0.8-2.9 GeV/c. In particular, a K^-–p resonance appea 1 GeV/c. R.J.N.

16898 SOME CONSIDERATIONS CONCERNING FINAL-INTERACTIONS AND THE REACTION $K_2^0 + p \rightarrow LAMBDA^0 + PI^+ + PI^0$. R.K.Adair.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 406-15 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Bubble c measurements in the region 1050 ± 300 MeV/c are describe their interpretation discussed. Effects of symmetries and c fugal barriers as well as final state interactions are discuss π–Λ resonance is identified, with Q-value 129 MeV and width ≤ 20 MeV. If possible interference effects are neglected, th resonant state appears to be $S_{1/2}$. R.J.N.

16899 ON THE $K^+ + n \rightarrow K^0 + p$ SCATTERING AMPLITU POLES. V.Amar and M.Pauri.
Nuclear Phys. (Internat.), Vol.27, No. 1, 52-7 (Sept., 1961).

The process $K^+ + n \rightarrow K^0 + p$ is considered. The effects

ss of the introduction of the interaction

$$H' = 2fm_K[\bar{K}^+ K^0\pi^+ + \bar{K}^0 K^+\pi^-]$$

sed by Pais are examined by means of dispersion relations at energy. A useful formula for the estimation of f_R is obtained ndard methods. A concrete possibility of discriminating en the models of Pais and of Gell-Mann is investigated. y, some consequences for isobaric conservation rules in the ryon interactions are discussed in connection with the possible nce of a vertex like $\bar{K}K\pi$, whether elementary or not.

perons

900 HYPERON PHOTON-DECAY. G.Calucci and G.Furlan.
Cimento (Italy), Vol. 21, No. 4, 679-83 (Aug. 16, 1961).
ollowing the method and suggestion of the work of Feldman, and Matthews (Abstr. 547 of 1961), the $Y \to N + \gamma$ decay is d. A "pole" approximation is discussed in order to evaluate cay rate and other characteristic parameters of the process. F.Herbut

901 HELICITY OF THE PROTON FROM Λ DECAY. J.Leitner, L.Gray, E.Harth, S.Lichtman, J.Westgard, ck, B.Brucker, A.Engler, R.Gessaroli, A.Kovacs, T.Kikuchi, itzer, H.O.Cohn, W.Bugg, A.Pevsner, P.Schlein, M.Meer, rinellini, L.Lendinara, L.Monari and G.Puppi.
Rev. Letters (USA), Vol. 7, No. 6, 264-8 (Sept. 15, 1961).
he study of about 2000 Λ^0 hyperons produced by K^- absorption using the Duke University helium bubble chamber and the ley low-energy K^--beam, indicates a positive helicity for the n from the Λ decay. The result is based on 105 proton scatter- ents. S.J.St-Lorant

902 PRODUCTION OF $\Lambda^0(\Sigma^0)$ HYPERONS AND K^0 MESONS IN π^-p INTERACTIONS AT 6.8 ± 0.6 BeV/c. an-Chan [Wang Kang-Ch'ang], Van Tsu-Tszen Ts'u-Tseng], V.I.Veksler, I.Vrana, Din Da-Tsao Ta-Ts'ao], V.G.Ivanov, E.N.Kladnitskaya, A.A.Kuznetsov, Din Tỹ [Nguyen Dinh Tu], A.V.Nikitin, M.I.Solov'ev and Lin-Yan' [Ch'êng Ling-Yen].
ksper. teor. Fiz. [USSR), Vol. 40, No. 2, 464-74 (Feb., 1961).
ssian.
he cross-section for the production of $\Lambda^0(\Sigma^0)$ and K^0 particles, atio between the Y^0K and $K\bar{K}$ pair production cross-sections, ean multiplicity of charged particles, the c.m.s. angular and entum distributions of Λ^0 and K^0 particles, and the transverse entum distributions for Λ^0 and K^0 particles were obtained. [English lation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 0 (Aug., 1961)].

903 DISPERSION RELATIONS FOR VERTEX PARTS. Yu.M.Malyuta.
ksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1128-33 (April, 1961).
ssian.
he primitive diagrams are found and the location of the nearest larities for the $\Lambda\Lambda\pi$, $\Lambda\Sigma\pi$ and $\Sigma\Sigma\pi$ vertex parts are determined king use of the Nambu—Symanzik majorization method. The nt investigation differs from Nambu's study of the hyperon form (Abstr. 55 of 1959) in that the author does not restrict himself consideration of a simplified model but studies the situation rises when all strongly interacting particles are allowed to st. [English translation in: Soviet Physics—JETP (USA), 3, No. 4, 795-803 (Oct., 1961)].

904 LEPTONIC DECAY OF Σ-HYPERON. B.Bhowmik.
Cimento (Italy), Vol. 21, No. 3, 567-70 (Aug. 1, 1961).
he author claims that an event found amongst a sample of eron decay during the course of an analysis of K^- states in mulsion stacks exposed to the magnetically separated ley K^- beam is a case of leptonic decay of a Σ^- hyperon e^- as charged secondary. A K^- meson incident from the direction and identified by g* range measurements came ently to rest in the expected region of stopping K^- mesons. e tracks were produced at its end, a grey track of range mm which was identified as a π^+ meson, a black track of 381 μm which was identified as a proton and a short prong was interpreted as the decay of a Σ^- hyperon, produced by apture of the K^- meson by a bound proton. J.H.Gunn

16905 Σ—Λ RELATIVE PARITY AND THE $\Sigma^0 \to \Lambda^0 + \gamma + \gamma$ DECAY. S.Chiba, S.Oneda and J.C.Pati.
Phys. Rev. (USA), Vol. 124, No. 2, 611-14 (Oct. 15, 1961).
It is shown that the π^0-pole term predicts a large difference of nearly two to three orders of magnitude for the branching ratio of the $\Sigma^0 \to \Lambda^0 + 2\gamma$ decay mode, depending upon the value of the Σ—Λ relative parity. It is further argued that this difference is not masked, even if one includes other diagrams. It is thus suggested that a study of the branching ratio of the $\Sigma^0 \to \Lambda^0 + 2\gamma$ decay may serve to determine the Σ—Λ relative parity.

16906 PRODUCTION OF HYPERONS IN HYDROGEN BY POSITIVE PIONS. C.Baltay, H.Courant, W.J.Fickinger, E.C.Fowler, H.L.Kraybill, J.Sandweiss, J.R.Sanford, D.L.Stonehill and H.D.Taft.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 374-81 (July, 1961).
Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Bubble chamber measurements of $\pi^+ + p \to \Sigma^+ + K^+$ at 0.91, 0.98, 1.09 and 1.26 GeV are described. It appears that the angular distribution changes rapidly, that angular momenta $L \geq 2$ are involved at the two higher energies, and that the Σ^+ polarization at 1.09 GeV is small. The results are consistent with charge independence, compared with Σ^- and Σ^0 production data. R.J.N.Phillips

THE THEORY OF "STRANGE" PARTICLES. See Abstr. 16671

16907 THE NEW PARTICLES AND THE BARYON MASS SPECTRUM. A.I.Solomon.
Nuclear Phys. (Internat.), Vol. 26, No. 3, 452-6 (Aug., 1961).
Considers the effects of the new strange particles which complete the Gell-Mann—Nishijima scheme on the mass levels of the baryons from the point of view of perturbation theory. It is shown that the observed baryon mass spectrum ordering may be obtained by a suitable choice of parities.

16908 DETERMINATION OF THE PARITIES OF STRANGE PARTICLES BY MEANS OF DISPERSION RELATIONS. Ya.I.Granovskii and V.N.Starikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 537-45 (Feb., 1961). In Russian.
The set of dispersion relations of Matthews and Salam (Abstr. 4247 of 1958), Igi (Abstr. 13054 of 1960), and Amati (Abstr. 7287 of 1959) for the scattering of K mesons by protons is regarded as a (overdetermined) system of equations for the parities and the coupling constants of the proton with the K—Y pair. The condition for consistency leads to the result that the parities of Λ and Σ hyperons are opposite. The sign of the real part of the amplitude for scattering of a K^- meson by a proton turns out to be positive, so that there are attractive forces in the Kp system. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 375-80 (Aug., 1961)].

16909 CROSS SECTION FOR STRANGE PARTICLE GENERATION. V.S.Barashenkov, E.K.Mihul and Huang Tzu-Tzan.
Acta. phys. Polon. (Poland), Vol. 20, No. 8, 657-62 (1961).
Multiple production of strange particles is treated, and the resonance interaction of strange particles is taken into account. The law of strangeness conservation is taken into consideration more exactly. It is shown, by taking the example of slow antinucleon annihilation and pion—nucleon collisions at 1.7 BeV, that the theoretical cross-sections for strange-particle production may be brought into agreement with the experimental data.

16910 SOME REMARKS ABOUT THE PHOTOPRODUCTION OF STRANGE PARTICLES. M.Gourdin.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1035-7 (June 1, 1961).
The model of associated production (see following abstract) is extended to photoproduction. J.E.Paton.

16911 ASSOCIATED PRODUCTION OF STRANGE PARTICLES. M.Gourdin and M.Rimpault.
Nuovo Cimento (Italy), Vol. 20, No. 6, 1166-81 (June 16, 1961).
The reaction amplitude is considered as a sum of terms due partly to Born approximation and partly to resonance (π—N, π—γ and π—K). A computational procedure is outlined. It seems possible to explain backward peaking in Λ^0 and Σ^0 production in terms of a π—K $I = \frac{1}{2}$ resonance. J.E.Paton

16912 ON THE STRONG INTERACTIONS OF THE STRANGE PARTICLES. R.H.Dalitz.
Rev. mod. Phys. (USA), Vol. 33, No. 3, 471-91 (July, 1961).

Conference on Strong Interactions Paper, University of California, Dec., 1960 (see Abstr. 10847 of 1961). Describes the K-matrix formalism for coupled two-body channels, its application to low energy K^-—p scattering, and the possibility that the 1385 MeV π—Λ resonance may be a "virtual bound state". Discusses the use of dispersion relations in multi-channel problems. Reviews the present status of the global symmetry hypothesis, and the possibility that the π—Λ resonance may alternatively be an analogue of the lowest π—N resonance. R.J.N.Phillips

Deuterons

16913 CHARGED PRODUCTS OF THE REACTIONS He^4 + d (20 MeV). K.P.Artemov and N.A.Vlasov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1612-14 (Dec., 1960). In Russian.

The spectra and angular distributions of the charged products of the reactions between 20.2-MeV deuterons and He^4 were measured using photographic emulsions. The angular distributions of elastically-scattered deuterons and of the protons from the He^4(d,p)He^5 and He^4(d,pn)He^4 reactions are presented. The proton group from the He^4(d,p)He^5 (ground state) reaction was intense at small angles. A broad continuous proton spectrum was observed at large angles. The angular distribution of the continuous proton spectrum was similar to that of the elastically-scattered deuterons. The elastic scattering and the (d,pn) cross-sections are approximately equal. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1124-6 (June, 1961)].

16914 THE USE OF POLARISED DEUTERONS TO STUDY THE D + D REACTIONS.
J.R.Rook and L.J.B.Goldfarb.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 79-93 (Sept., 1961).

It is shown that further information on the spin transitions involved in the D + D reactions at low energies ($E_D < 1$ MeV) may be obtained by the use of polarized deuteron beams, but that a complete determination of the reaction matrix elements requires two double-polarization measurements. The selection rules on the spin transitions are discussed in terms of the internucleon forces and the earlier formulae giving the energy dependence of the cross-sections and polarization are slightly modified to give a further degree of freedom in fitting the experimental data.

16915 MEASUREMENT OF THE YIELD AND ENERGY SPECTRA OF D—D NEUTRONS BY MEANS OF NUCLEAR EMULSIONS. B.Anatolković, D.Winterhalter and M.Turk.
Period. math.—phys. astron. (Yugoslavia), Vol. 2, No. 4, 303-10 (1960).

The yield and energy spectrum of neutrons of 2.7 MeV energy from a heavy-ice target exposed to deuterons of 180 keV mean energy was measured by elastic scattering of the neutrons by protons in thin Ilford C2 emulsion pellicles. The effect of introducing into the beam several collimators with a different geometry was also studied. S.J.St-Lorant

Tritons

16916 REACTIONS IN THE A = 4 SYSTEM. III. T(p,n). J.E.Young and P.R.Stein.
Ann. Phys. (USA), Vol. 15, No. 2, 157-92 (Aug., 1961).

An analysis is presented of the charge exchange reaction T(p,n). The model used is basically that proposed by Selove, that is a direct interaction model. A cluster model (deuteron plus neutron) representation of the three-body ground state is assumed. Further, the relevant interactions, knock-on and core pickup, between proton and target are characterized through the Yamaguchi separable t-matrix, a nonlocal operator. The impulse approximation (t in the medium equals t for free scattering) is introduced. Certain other approximations having to do with the nuclear form factors and the smallness of momenta components of the bound neutron are also employed. Calculations are presented in which a comparison is made with the differential cross-sections at 1.75, 3.0, and 5.5 MeV. The observed dependence of back to forward scattering upon energy is well represented by the theory.

Alpha-particles

16917 INTERACTION BETWEEN ALPHA PARTICLES. I.Shimodaya, R.Tamagaki and H.Tanaka.
Progr. theor. Phys. (Japan), Vol. 25, No. 5, 853-5 (May, 1961)

By applying pion—theoretical potentials, interactions bet α-particles are investigated from the viewpoint of the cluste model. It is shown that all the known essential features of th interaction can be reproduced in this way without polarizing α-clusters. F

16918 PHOTODISINTEGRATION OF He^4 AT HIGH ENE R.I.Dzhibuti and A.V.Tagviashvili.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1756-9 (Dec., In Russian.

The two-particle model was used to find the angular dis and total cross-sections for photo-nucleons produced in the $He^4(\gamma,p)H^3$ and $He^4(\gamma,n)He^3$. The results are compared with e mental data. [English translation in: Soviet Physics—JETP Vol. 12, No. 6, 1225-7 (June, 1961)].

16919 THE STOPPING POWER OF GOLD FOR 14.36 M α-PARTICLES.
C.Gérardin, R.Bilwes and D.Magnac-Valette.
J. Phys. Radium (France), Vol. 22, No. 1, 62-4 (Jan., 1961). In French.

A disagreement in the published value of the range in go 4.5 MeV alphas prompted this determination of the range-en relationship in gold for alphas of 9 to 14 MeV. The slope of present curve above 10 MeV agrees well with that of Whalin [Handbuch der Physik (Germany), Vol. 34, 193 (1953)]. V.

16920 ELASTIC SCATTERING OF POLARIZED 10 MeV PROTONS BY He^3. L.Rosen and J.E.Brolley, Jr
J. Phys. Radium (France), Vol. 21, No. 5, 365-6 (May, 1960) In French.

Low and Mean Energy Nuclear Physics Colloquium, Gr 1960 (see Abstr. 12029 of 1961). A fully polarized beam of 1 protons is elastically scattered by He^3 and the angular depen the left-right asymmetry is determined. Strong polarization for the "back-scattered" protons suggest the possibility of p ing a spin—spin correlation experiment by measuring the co ponding He^3 polarization.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

16921 NUCLEAR EMULSIONS IN THE I.G.Y. C.J.Waddington.
J. photogr. Sci. (GB), Vol. 8, No. 2, 41-7 (March-April, 1960

The principal use of nuclear emulsions during the I.G.Y to monitor the α-particle component of the primary cosmic tion. The reasons for selecting this component of the radiat are discussed, and details given of the results obtained from material.

16922 THE MANCHESTER HIGH ENERGY MAGNETIC RAY SPECTROGRAPH.
J.E.R.Holmes, B.G.Owen and A.L.Rodgers.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 499-504 (Oct., 1961).

Modifications to the Manchester counter spectrograph a described which have permitted the momentum measuremen single cosmic-ray particles to a maximum detectable mome 1000 GeV/c. The measured output of the instrument was 20 per day of which approximately 50% had momentum exceedin 10 GeV/c and 2% exceeding 100 GeV/c.

16923 INFLUENCE OF THE NUCLEAR PHOTOEFFEC THE PRIMARY COSMIC RAY SPECTRUM.
N.M.Gerasimova and I.L.Rozental'.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 488-90 (Aug In Russian.

The effect of the nuclear photoeffect on the energy spec high energy primary cosmic rays was investigated. An esti

tes that it is very improbable for very high energy (~10^{18} eV) nuclei of intergalactic origin to appear in the Galactic. sh translation in: Soviet Physics–JETP (USA)].

5924 DOUBLE CLOUD-CHAMBER INVESTIGATION OF 500 m_e PARTICLES IN COSMIC RAYS.
Vendel, P.A.Piroué and G.T.Reynolds.
Rev. (USA), Vol. 124, No. 2, 580-3 (Oct.15, 1961).
The Princeton double cloud-chamber was used to investigate ass spectrum of long-lived cosmic-ray particles between the son and the proton masses. It was operated at two locations: cho Lake, Colorado (3250 m altitude and 42° geomagnetic de); (2) Princeton, New Jersey (sea level). The upper cloud ber operated in a magnetic field of 5500 G. The lower chamber ned 7 copper plates of 1.27 cm thickness each. The range of a ng particle was between 120 and 200 g/cm^2 Cu equivalent. No ction layer was used. At Echo Lake a water Cherenkov counter ncluded in the counter arrangement to bias against μ-mesons. ass of every stopping particle was determined from momentum nge. A measurement of the ionization by droplet counting was le in the upper chamber. No particle of about 500 electron es was found in either run as compared to an equivalent flux of 1000 stopped μ-mesons at Echo Lake and 1500 stopped μ-meson ns at Princeton. These results are in disagreement with the anian experiment (Abstr. 3411 of 1957).

5925 THE TWO-CENTRE MODELS OF PARTICLE EMISSION IN COSMIC-RAY JETS.
negr, V.Šimák and M.Vötruba.
Cimento (Italy), Vol. 21, No. 3, 555-8 (Aug. 1, 1961).
n analysis of 80 jets with $n_s \geq 6$ and $N_h \leq 2$, from both lished and previously published sources, in terms of the "fire- and isobar models. It is concluded that the isobar model fits iment well at energies below 10^{12} eV, and that the fireball applies at energies greater than 10^{12} eV; but that the bound- egion between the models is broad, and that other factors be- primary energy may influence the interaction. N.A.Porter

5926 COSMIC RAY AND GEOMAGNETIC DISTURBANCES FROM JULY 1957 TO JULY 1958. III. THE CORRELATION WITH SOLAR RADIO BURSTS.
helet, P.Balata, A.M.Conforto and G.Marini.
Cimento (Italy), Vol. 21, No. 4, 648-58 (Aug.16, 1961).
For Pt I-II see Abstr. 15490-1 of 1960. A statistical approach cussed to the comparison of the time correlation of solar radio s of spectral types II and IV with geomagnetic and cosmic-ray ns. The analysis is carried out for the events of the period 957-July 1958. The solar radio bursts best correlated to the ysical perturbations under study turn out to be type IV radio s, although the correlation is far from being of the "one to one" cter. The comparison with other authors' results makes it that a better definition of type IV emission is fundamental in espect.

5927 LOW-ENERGY SOLAR COSMIC RAYS AND THE GEOMAGNETIC STORM OF MAY 12, 1959.
inckler and P.D.Bhavsar.
phys. Res. (USA), Vol. 65, No. 9, 2637-55 (Sept., 1960).
uring a strong geomagnetic storm on May 11-12, 1959, and ing a class 3+ chromospheric solar flare on May 10, a large ity of low-energy solar cosmic-ray protons was observed in a n flight at 30 km altitude at Minneapolis, Minnesota. The s obtained with an ion chamber, Geiger counter, and scintilla- ounter are reported. The proton flux of energy above 100 MeV l from 52 to 1.7 cm^{-2} sec^{-1} sterad^{-1} during the time 0400 to JT on May 12. The spectrum obtained with the counting instru- is consistent with detailed emulsion studies and has the form = $CE^{-\gamma}$. With E in MeV, γ varies from 5 to 2 during the above eriod. The scintillation counter showed excess γ-radiation he nuclear effects of the cosmic-ray protons, and intense of auroral X-rays, particularly at 0835 UT on May 12. The optical and radio features of the flare are discussed, and the onship of the polar-cap ionospheric black-out to the Minneapolis rements is considered. The cosmic-ray protons at Minneapolis easured at energies well below the normal Störmer cutoff for titude. Several theories on this subject are presented.

6928 FORBUSH DECREASE OF THE FLUX OF HEAVY PRIMARY NUCLEI OF COSMIC RAYS ON MAY 12 AND 12, 1959. S.Biswas.
phys. Res. (USA), Vol. 66, No. 9, 2653-7 (Sept., 1961).
The time variation of the flux of heavy nuclei with Z ≥ 3 of primary cosmic radiation was measured during seven balloon flights on May 6-12, 1959, and on July 10-12, 1959. Six of these flights were made from Minneapolis and one from Churchill, Canada. During a quiet day on May 6, 1959, the flux of these nuclei at the top of the atmosphere was 21.2 ± 2.3 particles m^{-2} sec^{-1} sr^{-1}. After the Forbush decrease on May 12, 1959, the value was 10.0 ± 1.4 particles m^{-2} sec^{-1} sr^{-1}, showing a reduction of 53 ± 9% of the primary heavy nuclei flux. On July 10-11, the flux of Z ≥ 3 nuclei at the top of the atmosphere was measured as 17.5 ± 1.7 particles m^{-2} sec^{-1} sr^{-1} before the Forbush decrease and 10.0 ± 1.8 particles m^{-2} sec^{-1} sr^{-1} after the Forbush decrease on July 12. The reduction was 43 ± 9% during this event. The Deep River neutron monitor showed a reduction of counting rates of 12 and 7.5% respectively during these two Forbush decrease events.

COSMIC RAY VARIATIONS JULY 10-19, 1959.
See Abstr. 15251

16929 THE SPECTRUM AND PROPAGATION OF RELATIVISTIC SOLAR FLARE PARTICLES DURING JULY 17-18, 1959. H.S.Ghielmetti.
J. geophys. Res. (USA), Vol. 66, No. 6, 1611-25 (June, 1961).
In the interval July 17-18, 1959, one solar charged particle intensity increase was definitely observed before a sharp Forbush type decrease, and a second appeared likely following the decrease. These events were detected at sea level and at mountain altitudes. The first event followed the giant solar flare of July 16, and the solar particles appeared to arrive isotropically at the earth. The intensity time dependence of this event showed a slow rise-time comparable with its exponential decay. The integral rigidity spectrum for these particles was approximately $(cp/ze)^{-9}$. The second event, although not uniquely determined as a solar flare event, followed some minor solar flare activity and might be explained by assuming an anisotropy (impact zones for the source in the solar direction) for several hours. The integral rigidity spectrum for this second event was $(cp/ze)^{-4.5}$. This sequence of intensity increases could be explained by the diffusion of solar particles from the July 16 flare through disordered magnetic fields to reach the earth isotropically. The effect of the mechanism for the subsequent Forbush intensity decrease is to smooth the interplanetary fields so as to leave behind only weak, regular fields through which the fast moving solar particles of July 18 arrive anisotropically at the earth.

COSMIC RAY VARIATIONS MARCH 29-APRIL 5, 1960.
See Abstr. 15252

16930 SOLAR FLARE COSMIC-RAY INCREASE OF MAY 4, 1960. R.B.Brode, R.R.Brown and W.R.Steiger.
J. geophys. Res. (USA), Vol. 65, No. 12, 4200-1 (Dec., 1960).
Observations of cosmic-ray intensity obtained with neutron monitors diving the period 1000 to 1200 UT of May 4, 1960 at Berkeley, California and Hawaii, are presented. At 1020 UT a solar flare of importance 2 occurred. Following the flare the counting rate of the Berkeley monitor showed an increase of approximately 50%. The intensity was increased beyond the preflare level between 1030 and 1032 UT, reached to maximum value between 1038 and 1040 UT, and then returned to the preflare level by 1100 UT. During the same time interval the Hawaii monitor showed no intensity variations outside the statistical fluctuations.
C.F.Barnaby

16931 THE HIGH-ENERGY COSMIC-RAY FLARE OF MAY 4, 1960. I. HIGH-ALTITUDE IONIZATION AND COUNTER MEASUREMENTS.
J.R.Winckler, A.J.Masley and T.C.May.
J. geophys. Res. (USA), Vol. 66, No. 4, 1023-7 (April, 1961).
Total ionization and counting rate measurements were made at 6 g cm^{-2} depth at Minneapolis in the period from 7 to 16 hr following the cosmic-ray flare of May 4, 1960. The excess energy influx 7 hr after the flare was 340 MeV cm^{-2} sec^{-1} in an atmospheric column. The omnidirectional ionization and counting rates were about 25% above normal and the ionization ratio per particle was 1 : 2 times that of normal galactic cosmic rays at the same altitude. This is consistent with the high-energy nature of the event and contrasts greatly with the steep low-energy spectrum frequently observed during geomagnetic disturbances at Minneapolis. There is evidence for a displaced impact zone effect in the period 7 to 15 hr after the flare.

16932 THE HIGH-ENERGY COSMIC-RAY FLARE OF MAY 4, 1960. II. EMULSION MEASUREMENTS.
S.Biswas and P.S.Freier.
J. geophys. Res. (USA), Vol. 66, No. 4, 1029-34 (April, 1961).

The differential energy spectrum of solar protons from the flare of May 4, 1960 was measured in emulsions during a balloon flight from 1700 UT on May 4 to 0200 UT on May 5. An increased flux of protons of rigidity 0.7 to 1.6 bV of 600 ± 150 particles cm^{-2} sec^{-1} $ster^{-1}$ was measured. The differential rigidity spectrum in this interval can be expressed as

$$\frac{dN}{dR} \quad \frac{(0.65 \pm 0.15) \times 10^{-3}}{R^{1.1 \pm 0.5}} \text{ protons } m^{-2} \text{ sec}^{-1} \text{ ster}^{-1} \text{ bV}^{-1}$$

There were no solar α-particles present during this time. The flux of $Z \geq 3$ nuclei was normal.

16933 SOLAR FLARE COSMIC-RAY EVENT OF MAY 4, 1960.
K.Maeda, V.L.Patel and S.F.Singer.
J. geophys. Res. (USA), Vol. 66, No. 5, 1569-72 (May, 1961).

The cosmic-ray intensity associated with the solar flare of May 4, 1960, (at approximately 10.30 UT) was observed with: (1) total component cosmic-ray telescopes operated at Alberta, Canada and at Climax, Colorado; (2) a standard cubical meson telescope at Thule; (3) a plastic scintillation cosmic-ray detector at Maryland. C.F.Barnaby

16934 SOLAR-PRODUCED COSMIC RAYS FOLLOWING THE SOLAR FLARES OF NOVEMBER 12 AND 16, 1960.
B.Trumpy and T.Svanes.
Arbok Univ. Bergen mat.-nat. Ser. (Norway), 1961, Paper 14, 14 pp.

Presents the results of measurements in Bergen, Norway. Altogether 10 different components were studied: the neutron component, the total radiation, the soft component and several hard components incident from different directions. In the neutron component, increases of 90% and 84% were observed on November 12 and 15, the first one having a doublet structure. A corresponding increase in the other cosmic ray components was not observed, showing that solar-produced cosmic radiation has a low energy spectrum. At about 18.30 U.T. on November 12 a Forbush-decrease occurred in these soft and hard cosmic ray components. The expiration of this Forbush-decrease is described, and its connection with the simultaneous variations in the neutron component is discussed. On the basis of experimental material from several other recording stations an approximate integral energy spectrum is found for the solar produced radiation responsible for the various maxima in the intensity curves for the neutron component. The analysis of a small intensity increase in all the recorded components at about 9.30 U.T. on November 13 — prior to a strong Forbush-decrease — shows that this augmentation effect is probably due to a reflection of cosmic ray particles from the approaching face of magnetized solar plasma.

16935 CHARACTERISTICS AND FINE STRUCTURE OF THE LARGE COSMIC-RAY FLUCTUATIONS IN NOVEMBER 1960. J.F.Steljes, H.Carmichael and K.G.McCracken.
J. geophys. Res. (USA), Vol. 66, No.5, 1363-78 (May, 1961).

Measurements obtained at Deep River, Canada, from two large neutron monitors, and at Cambridge, Massachusetts, from a high counting rate meson monitor, during the solar cosmic-ray injections of November 12 and 15, 1960, are reported. In addition, rate-meter pen traces of the neutron increases and a magnetometer trace of H, obtained at Deep River, are reproduced. The solar cosmic-ray increase of November 12 appears to be unique in that while it was in progress a sharp Forbush decrease happened to occur as shown by the MIT meson intensity. Half an hour before the onset of the Forbush decrease, and coincident with a conspicuous increase of H, the intensity of the solar cosmic radiation doubled and then exhibited strong rapid oscillations. Arguments are advanced that the changes of intensity of the solar cosmic rays observed at high latitudes at the time of the magnetic disturbance and Forbush decrease are due to the earth sampling solar cosmic rays trapped in the gas cloud responsible for these latter effects. The events of November 12 and 15 are both shown to be in agreement with a recent model for the magnetic fields in the inner solar system. At the time of the solar cosmic-ray increase of November 15, the earth was already inside a trapping region, and periodic oscillations of the solar cosmic-ray intensity were observed lasting for about 2 hr. It is suggested that these oscillations may be closely connected with the storage mechanism.

16936 ANGULAR DISTRIBUTION OF SHOWER PARTICL NUCLEAR INTERACTIONS OF FAST NUCLEONS HEAVY EMULSION NUCLEI.
S.A.Azimov, K.T.Teshabaev, L.P.Chernova, G.M.Chernov and V.M.Chudakov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1534-9 (Dec., 1
In Russian.

The angular distribution of shower particles is studied fo 70 showers (jets) produced by singly-charged or neutral cosm ray particles of 10^{10}–10^{12} eV, and possessing more than eight strongly-ionizing particles. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1068-71 (June, 1961)].

16937 CALCULATION OF THE TRANSITION EFFECT A VARIOUS DISTANCES FROM THE ELECTRON–PHOTON SHOWER AXIS. O.I.Dovzhenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1686-92 (Dec., In Russian.

A method for calculating the transition effect in thin laye matter ($t < 1$ radiation length) is developed for radiation cont of electrons and photons with an arbitrary spectrum. The re obtained are used for calculating the transition effect betwee air and the ionization-chamber wall at various distances r fr the electron–photon shower axis for $s = 1$ and for an infinite primary energy. Electron- and photon-energy spectra at var distances r from the shower axis are derived by the moment [English translation in: Soviet Physics—JETP (USA), Vol. 1 No. 6, 1178-82 (June, 1961)].

16938 INVESTIGATION OF NUCLEAR-ACTIVE PARTIC AND ELECTRON–PHOTON SHOWERS WITH ENERGIES > 10^{12} eV AT 3860 m ALTITUDE. E.V.Denisov, V.I.Zatsepin, S.I.Nikol'skii, A.A.Pomanskii, B.V.Subbotin, E. and V.I.Yakovlev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 419-25 (Feb., 1
In Russian.

An experimental arrangement for studying the interactio between nuclear-active particles with energies > 10^{12} eV and and carbon nuclei is described. Preliminary results on the e spectrum of nuclear-active particles with energies > 10^{12} eV discussed. [English translation in: Soviet Physics—JETP (U Vol. 13, No. 2, 287-91 (Aug., 1961)].

16939 CALCULATION OF SOME EXTENSIVE AIR SHOW CHARACTERISTICS WITH ALLOWANCE FOR FLUCTUATIONS. L.G.Dedenko.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 630-6 (Feb., 19
In Russian.

The size spectrum of EAS at 640 g/cm^2 altitude (the Par produced by 10^{13}, 10^{14} and 10^{15} eV protons, is calculated with ance for fluctuations in the number and altitude of the primar proton collisions. The energy spectrum of protons producing showers of a given size at the observation level is determine size spectrum of showers produced by primary protons, α-p and oxygen nuclei is calculated. [English translation in: Sov Physics—JETP (USA), Vol. 13, No. 2, 439-43 (Aug., 1961)].

16940 PHOTOGRAPHY OF CERENKOV [CHERENKOV] FROM EXTENSIVE AIR SHOWERS IN THE ATMO SPHERE. D.A.Hill and N.A.Porter.
Nature (GB), Vol. 191, 690 (Aug. 12, 1961).

An image intensifier system triggered by a photomultipl was used to photograph the Cherenkov light. Thirty two show were photographed in 8 hours. Comparison of the film densi produced by a shower and a star of known magnitude provide approximate estimate of the shower size. The direction of t showers can be determined with accuracy better than 0.5°. J.L.

16941 THE ENERGY SPECTRUM OF μ-MESONS IN EX TENSIVE AIR SHOWERS.
T.Shandor, A.Shomogi and F.Telbisz.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 334-6 (Aug.
In Russian.

The power exponent of the energy spectrum of shower μ-mesons is determined by comparing the intensity of the penetrating component of extensive air showers at a depth of water equivalent with that at sea level. The result is $F(>E)$ where $\alpha = 0.46 \pm 0.09$. [English translation in: Soviet Phys JETP (USA)].

16942 FLUCTUATIONS OF THE μ-MESON FLUX IN EXTENSIVE AIR SHOWERS.
.Vernov, V.I.Solov'ova, B.A.Khrenov and G.B.Khristiansen.
eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 340-53 (Aug., 1961).
tussian.

Fluctuations of the μ-meson flux in extensive air showers with escribed number of particles $N(N > 10^6)$ were studied with aid n arrangement which measured simultaneously the total number hower particles and number of μ-mesons in the shower. It is onstrated that the fluctuations can be explained by fluctuations he height at which the primary shower producing particle eriences its first interaction. The data obtained are used to ermine the interaction free path for the ultra-high energy primary ticles producing the extensive showers. [English translation in: iet Physics–JETP (USA)].

16943 THE INFLUENCE OF SMALL FLARES ON THE INTENSITY OF THE NEUTRON COMPONENT OF COSMIC YS. P.Chaloupka, M.Jireš and T.Kowalski.
ech. J. Phys., Vol. 10, No. 10, 769-71 (1960).

From a study of data obtained during 1958 it is concluded that all solar flares do not significantly influence the intensity of the tron component. This conclusion confirms that of Towle and kwood (Abstr. 4770 of 1959), but disagrees with that of omeets (Abstr. 10502 of 1960). However, the effect described Kolomeets can be explained by the diurnal variation.

G.R.Greatrix

16944 OBSERVATIONS OF THE COSMIC-RAY EQUATOR IN THE PACIFIC OCEAN AREA. R.A.Hubach.
geophys. Res. (USA), Vol. 66, No. 1, 321-2 (Jan., 1961).

The results obtained of a latitude survey of the intensity of the leonic component of cosmic radiation in the Pacific Ocean area summarized. The location of the cosmic-ray equator (position of imum intensity) was determined in a longitude range that had previously been investigated with a detector of the type used(a tron monitor). The results were obtained during three round ps between San Francisco and Sydney from May to November, 9. It was found that the positions of the cosmic-ray equator at ° and 166° W Geographic Longitude were 4° 30' ± 1° 30' S and 0' ± 2° 00' S Geographic Latitude respectively. The results compared with those obtained using theoretical methods.

C.F.Barnaby

16945 MEASUREMENTS OF THE MOMENTUM SPECTRUM AND CHARGE RATIO OF COSMIC RAY MUONS AT SEA VEL IN THE MOMENTUM RANGE 10 GeV/c–1000 GeV/c.
.R.Holmes, B.G.Owen and A.L.Rodgers.
c. Phys. Soc. (GB), Vol. 78, Pt 4, 505-15 (Oct., 1961).

The momentum spectrum of single cosmic-ray muons arriving ea level in the north–south plane at 57°N geomagnetic latitude measured for near vertical incidence. Results are given which er the momentum range $5 \text{ GeV/c} < p < 1000 \text{ GeV/c}$, and together n the earlier work of Owen and Wilson (Abstr. 5499 of 1955) form ntinuous spectrum from 0.5 GeV/c to 1000 GeV/c. The high-mentum work is based on 1800 particles of momentum greater n 10 GeV/c. The charge ratio of single muons arriving at sea el was measured, for near vertical incidence, to an upper mentum limit of 100 GeV/c. The measurements are compared n those of other workers and together show evidence for a ximum in the sea-level charge ratio in the momentum range eV/c to 7 GeV/c.

16946 SEASONAL VARIATIONS OF COSMIC-RAY INTENSITY IN POLAR REGIONS. K.Maeda and V.L.Patel.
geophys. Res. (USA), Vol. 66, No. 5 1389-94 (May, 1961).

A seasonal variation of cosmic-ray intensity was observed at opposite polar stations, one at Thule in Greenland and the other Vilkes in Antarctica. They are in antiphase, with a maximum in al winter. The seasonal variation can be accounted for almost pletely by atmospheric effects, although a small extraterrest- contribution cannot yet be excluded. Abnormally large values the atmospheric temperature effects at these stations (a coeffic- −8.3 ± 0.9% km for the reference level of 300 mb at Thule and .5 ± 2.1% km at Wilkes) have been found. This can be ascribed low altitude of the effective muon-production level in polar ions.

16947 RIGIDITY DEPENDENCE OF SOLAR DIURNAL VARIATION OF COSMIC RAY INTENSITY.
S.P.Duggal, K.Nagashima and M.A.Pomerantz.
J. geophys. Res. (USA), Vol. 66, No. 6, 1970-3 (June, 1961).

It is pointed out that in earlier theoretical calculations of the diurnal variation in the primary cosmic-ray intensity, the orientational difference between the earth's rotational and the geomagnetic dipole axes was neglected. The present note attempts to determine values of the parameters involved in the more complete analysis required to take this factor into account. Experimental data is taken from a much wider geographical distribution of stations than has been considered heretofore. C.F.Barnaby

16948 A CRITICAL APPRAISAL OF SOME COSMIC RAY DATA FOR THE I.G.Y. R.P.Kane.
Proc. Indian Acad. Sci. A, Vol. 52, No. 2, 69-79 (Aug., 1960).

Cosmic ray recordings made with comparable instruments at stations where one would expect similar responses to slight variations of intensity were examined. Discrepancies of the order of a few per cent are sometimes observed, which are often too large to be explained either on the basis of statistical errors or through the application of incorrect meteorological corrections. The order of magnitude of the discrepancies in intensity averaged on a bi-hourly, 6-hourly and 24-hourly basis is evaluated. The validity of drawing conclusions of physical significance from the IGY data under various conditions is discussed. The appropriate statistics tests to available data are considered.

16949 LATITUDE DEPENDENCE OF THE DAILY VARIATION OF COSMIC RAY INTENSITY.
R.P.Kane and S.R.Thakore.
Proc. Indian Acad. Sci. A, Vol. 52, No. 3, 122-9 (Sept., 1960).

The yearly average daily variation curves for the period July 1957 to June 1958 for data from neutron monitors operated at various places during the IGY are harmonically analysed. Data for different latitude belts are grouped together. The amplitude and hour of maximum of the first harmonic show a marked latitude dependence. It is found however, that stations in the same latitude belt show large differences in amplitudes. Possible reasons for such differences are discussed. It is concluded that they are due to extraneous unspecified factors and the published data are not suitable for analysis without further scrutiny.

16950 ATMOSPHERIC EFFECTS ON THE INTENSITY OF COSMIC-RAY MESONS. I. THE BAROMETER EFFECT.
M.Wada.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 4, 335-52 (Dec., 1960).

A statistical method of obtaining Trefall's total barometer coefficient (Abstr. 2216 of 1956) by multiple correlation is proposed. It is a method to use for the term expressing the temperature effect in terms of the isobar height, measured, not from the ground but from an isobar level near the ground, as one of the variables for correlation. It is shown that, instead of the height, the mean temperature obtained by using the partial temperature coefficient or the mean mass temperature can also be used in the proposed method. The total barometer coefficient is calculated theoretically as a function of momentum, zenith angle, latitude and altitude. Momentum spectra of mesons and altitude curves of meson intensity, both of which are obtainable by direct measurements, are used as the basis of this calculation. The coefficient thus obtained is rearranged to become the coefficient for the standard meson monitor. By expressing it as a function of latitude and altitude, the coefficient for the monitor at every existing observatory is derived and listed for convenience in practical use for barometer correction. Statistical investigation of the barometer effect is carried out by using the data obtained in Tokyo. The total barometer coefficient was $-(0.147 \pm 0.003)\% \text{ mb}^{-1}$ which is in good agreement with the theoretically estimated value. From this value, the coefficient for sea level at high latitudes is found as $-0.17\% \text{ mb}^{-1}$.

A STUDY OF VARIATIONS OF THE CORPUSCULAR RADIATION OBSERVED BY SATELLITE 1958 EPSILON NEAR JAPAN.
See Abstr. 15338

16951 RADIOACTIVITY PRODUCED IN DISCOVERER XVII BY NOVEMBER 12, 1960, SOLAR PROTONS.
J.T.Wasson.
J. geophys. Res. (USA), Vol. 66, No. 9, 2659-63 (Sept., 1961).

Scintillation-spectroscopy measurements on a AgBr emulsion

block from Discoverer XVII, which was flown during a period of high solar cosmic-ray activity on November 12, 1960, reveal a gamma-ray spectrum attributable to 8.4-day Ag^{106}. The disintegration rate, corrected to a probable production time of 2200 UT, November 12, 1960, is 14 dis sec^{-1}. If a (p,pn) cross-section of 100 mb is assumed and the thin-target formula for production of radioactivity is applied, this corresponds to a total proton dosage of about 1.6×10^8 protons cm^{-2} within the emulsion, and to a value of 16 rads radiation dosage. An attempt to measure the gamma spectrum of 40-day Ag^{105} was unsuccessful, allowing the assignment of an upper limit on the disintegration rate of 1 dis sec^{-1} at the time of production. A search for 1.3-year Cd^{109} was unsuccessful.

SPATIAL CONSTANCY OF COSMIC RADIATION USING METEORITES AS SPACE PROBES. See Abstr. 15436

SPATIAL CONSTANCY OF COSMIC RAYS BY MEASUREMENT OF A^{37}, A^{39}, AND TRITIUM IN METEORITES. See Abstr. 15437

16952 COSMIC-RAY PRODUCTION OF LOW-ENERGY GAMMA RAYS. F.C.Jones.

J. geophys. Res. (USA), Vol. 66, No. 7, 2029-42 (July, 1961).

An attempt was made to detect and measure any vertically incident flux of low-energy (0.25 to 10 MeV) γ-rays that might be present at high altitudes. The experiment consisted of a series of balloon flights carrying a phoswitch gamma spectrometer with pulse height recording to altitudes of about 5.5 g cm^{-2} atmosphere depth. Directional sensitivity was obtained by placing a lead collimating shield around the detector and by periodically opening and closing a lead shutter above the opening of the shield. At altitudes between 5.4 and 6.0 g cm^{-2} atmospheric depth the experiment yielded a value of 0.000 ± 0.034 photons sec^{-1} cm^{-2} $sterad^{-1}$ for the vertical flux of gamma rays in the vicinity of 0.5 MeV energy. This is a null result; however, it places a new upper limit on the verticle γ-ray flux that is lower than any previously reported for this energy region. At lower altitudes it was observed that γ-rays are generated by cosmic rays in the atmosphere and in the collimating lead shield. At an atmospheric depth of 300 g cm^{-2} the flux of γ-rays from the atmosphere was about 0.3 photons sec^{-1} cm^{-2} $sterad^{-1}$. Convincing evidence was found that the γ-rays of atmospheric origin were generated by the secondary nucleonic component, and that they are not genetically related to the electromagnetic or 'soft' component of the secondary cosmic rays.

VERY-HIGH-ENERGY REACTIONS OF COSMIC-RAY PARTICLES WITH EMULSION NUCLEI. See Abstr. 13866

ANGULAR DISTRIBUTIONS OF HIGH-ENERGY MUONS IN THE ATMOSPHERE AND THEIR PRODUCTION MECHANISM. See Abstr. 16834

THE PRODUCTION AND PROPERTIES OF MESONS AT HIGH ENERGIES. See Abstr. 16844

NUCLEUS

16953 AN INVESTIGATION OF THE PROPERTIES OF TRANSURANIUM ELEMENTS BASED ON THE SUPERFLUID MODEL OF THE NUCLEUS. V.G.Solov'ev.

Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 654-65 (Feb., 1961). In Russian.

The properties of strongly deformed transuranic elements are investigated on the basis of the superfluid model of the nucleus. Some insignificant modifications are introduced in Nilsson's schemes by employing the experimental data and taking into account the effect of superfluidity. The pairing energies are computed and the following values for the coupling constants are obtained: $G_N = 0.020\ \hbar\omega_0$, $G_p = 0.022\ \hbar\omega_0$, where $\hbar\omega_0 = 41\ A^{-1/3}$ MeV. Single-particle excitation spectra are calculated for odd-mass nuclei, the calculated level density being about twice as large as that predicted by the Nilsson scheme. Single-particle excitations in even—even nuclei are computed, and in all the calculated spectra for the even—even nuclei (Th^{232}, U^{234}, Pu^{238}, Pu^{240}, Pu^{242}, Cm^{246}, Cf^{248}) the lowest levels are found to be the 1^- levels, which lie below 1 MeV. Corrections due to superfluidity of the ground and excited states are computed for the β - and γ-transitions. The results obtained are self-consistent: correct values for pairing energies and levels of even and odd nuclei are obtained for the same values of G, wher variation of G by 30-40% leads to a pronounced deviation from t experimental data. [English translation in: Soviet Physics—JE (USA), Vol. 13, No. 2, 456-64 (Aug., 1961)].

16954 ACCURACY OF THE SUPERCONDUCTIVITY APPRO MATION FOR PAIRING FORCES IN NUCLEI.

A.K.Kerman, R.D.Lawson and M.H.Macfarlane.

Phys. Rev. (USA), Vol. 124, No. 1, 162-7 (Oct. 1, 1961).

The authors exactly diagonalize the pairing force for certai nuclei and compare the results with those obtained from the approxi calculation of Kisslinger and Sorensen (Abstr. 17458 of 1960). Whe energy is computed by use of the approximate wave-function, wh is not an eigenfunction of the number operator, it is found that t excitation energies of the low-lying states with seniority one an two are correct to within 200 keV, whereas the ground-state energies are usually not given to better than 500 keV. The wave function obtained by projecting out and normalizing that part of t variational trial function that corresponds to the correct numbe particles is found to agree closely with the exact energy eigen-function. Overlap integrals greater than 98% are found in all ca considered. The expectation values of the pairing Hamiltonian w respect to these projected wave-functions are therefore in excel agreement with the exact energy eigenvalues. The variational aspects of the superconductivity approximation are also discuss briefly.

16955 EVIDENCE FOR LARGE CLUSTERS FROM THE LE STRUCTURE OF HEAVY NUCLEI.

H.Faissner and K.Wildermuth.

Naturwissenchaften (Germany), Vol. 48, No. 10, 400-1 (1961).

It is suggested that changes in rotational properties of nucl occur at Z = 68 and N = 90 and also at N = 132 and that these ar due to cluster formation due to combined magic numbers of Z = 40 + 28 at Z = 68, N = 50 + 40 at N = 90 and N = 80 + 52 at N = 132. L.L.C

16956 REDUCED MATRIX ELEMENTS IN NUCLEAR SHE THEORY. V.K.Kembhavi.

Nuclear Phys. (Internat.), Vol. 27, No. 1, 38-40 (Sept., 1961).

Using harmonic-oscillator wave-functions, reduced matrix elements were expressed in terms of Talmi integrals and $3F_2$ series. The B coefficients of Brody, Jacob and Moshinsky (Abs 17469 of 1960) are shown to be related to $3F_2$ series, and some recurrence relations for the B coefficients are obtained. A tab of useful B coefficients is presented.

16957 CLASICAL SELF-CONSISTENT NUCLEAR MODEL R.G.Seyler and C.H.Blanchard.

Phys. Rev. (USA), Vol. 124, No. 1, 227-32 (Oct. 1, 1961).

The Thomas—Fermi method in simplest form is applied to find the radial distribution of nucleons in a spherical nucleus in the absence of Coulomb forces. Saturation is obtained by hypothesizing a two-body force quadratically dependent on relative momentum. The effective one-nucleon potential energy is there fore velocity dependent. Solving the basic integral equation and imposing generally accepted values for the average and Fermi kinetic energies in the nuclear matter limit ($A \to \infty$), gives a solution exhibiting surface and saturated interior regions. Fixi one more parameter (the force range, taken to be $\hbar/m_\pi c$) deter mines all numerical features (e.g., surface thickness, interactio strength) at reasonable values.

16958 VIBRATIONS OF SPHERICAL NUCLEI. T.Tamura and T.Udagawa.

Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1051-3 (June, 1961)

A modified dispersion relation is given, allowing for a long range correlation between protons and neutrons, of essentially same type as is assumed among protons and among neutrons. E.A.Sande

16959 THE OPTICAL NUCLEAR MODEL. F.M.Nicolau.

Z. Naturforsch. (Germany), Vol. 16a, No. 6, 603-11 (June, 1961) In German.

The Schrodinger equation satisfied by the neutron wavefunc is derived when this is averaged over an energy interval which much greater than the average level spacing between the resona of the compound nucleus. The potential involved in this equatio

on-local one, and is given in terms of the interaction between the neutron and the target nucleus and the wavefunctions of the get and the compound nucleus. The wavefunction of the system otally antisymmetrized in order to satisfy the Pauli exclusion nciple. Using a Serber force for the two body interactions and ermi gas model for the wavefunctions of the target and the mpound nucleus, the magnitude of the real and imaginary parts he potential used in the optical model of the nucleus is estimated.

ALPHA–DEUTERON MODEL OF THE Li^6 NUCLEUS.
Abstr. 17156

16960 MONTE CARLO CALCULATION OF NEUTRON EVAPORATION; EXCITATION ENERGY DEPENDENCE NUCLEAR LEVEL DENSITY.
andenbosch, J.R.Huizenga, W.F.Miller and E.M.Keberle.
lear Phys. (Internat.), Vol. 25, No. 3, 511-21 (June, 1961).
Experimental excitation function data in the heavy-element ion were analysed by a Monte Carlo technique to investigate the endence of the nuclear level density on excitation energy. The lysis supports the prediction of the completely degenerate mi gas model that the nuclear temperature varies as the square t of the excitation energy. The value of the level density para- ter "a" deduced from the experimental data is changed signifi- tly when shell and pairing effects are taken into account by placement of the characteristic energy surface from which the itation energy is measured.

16961 THE THEORY OF NUCLEAR MATTER.
J.S.Bell and E.J.Squires.
ances in Phys. (GB), Vol. 10, 211-312 (July, 1961).
An extensive account of the present position of theories of lear matter initiated some years ago, mainly by Jastrow and eckner. The basic ideas are introduced, the variational roach is discussed and methods are developed involving partial mations in perturbation theory. The difficulties confronted in latter approach, and their partial resolution by ideas from erconductivity theory, are analysed. Much of the formalism lso relevant in the theory of individual nuclei (see for example review by Eden 1959) and in fields other than nuclear physics e for example "The Many Body Problem", Les Houches, 1958). vever, the criterion in the selection of material was relevance to ground state of nuclear matter.

16962 THEORY OF NUCLEAR MATTER.
F.Mohling.
s. Rev. (USA), Vol. 124, No. 2, 583-601 (Oct.15, 1961).
The methods of quantum statistics previously developed by the hor are applied to the determination of properties of the ground e of nuclear matter. An expansion in powers of the pair-func- of quantum statistics is made and expressions are derived for momentum distribution, pair-correlation function, binding rgy, and effective single-particle energies. The leading terms hese expressions can be interpreted in terms of an effective -body interaction, and a model of nuclear matter which consists nteracting quasi-particles whose energies are the effective gle-particle energies is thereby suggested. The theory is com- ed with Brueckner's theory and also with Landau's phenomeno- cal theory of the Fermi liquid.

6963 EFFECT OF ROTATION ON PAIR CORRELATION IN NUCLEI. Yu.T.Grin'.
eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 445-50 (Aug., 1961).
ussian.
Corrections to the quantity Δ characterizing pair correlation are rmined in the second order in rotation in perturbation theory, rections to the rotation spectrum due to the dependence of Δ hence of the moment of inertia on the nuclear spin are estimated. glish translation in: Soviet Physics–JETP (USA)].

16964 NUCLEAR GROUND-STATE ENERGIES.
M.Yamada and Z.Matumoto.
Phys. Soc. Japan, Vol. 16, No. 8, 1497-1529 (Aug., 1961).
The proton and neutron separation energies and the β-decay rgies are estimated for most of the nuclei that have been covered or will be discovered in near future. In this estimation r semi-empirical rules for the proton and neutron separation rgies are used in addition to the available experimental data. se rules are also used to eliminate the wrong data and to rect the wrong interpretations of the experimental results. The "best" values thus obtained are tabulated. Explanations are given for some of the data which are eliminated or need large adjustments.

16965 SPECTROSCOPIC DETERMINATION OF THE SPIN OF Lu^{176} AND THE NUCLEAR MAGNETIC AND QUADRUPOLE MOMENTS OF Lu^{175} AND Lu^{176}.
J.Blaise, J.Bauche, S.Gerstenkorn and F.S.Tomkins.
J. Phys. Radium (France), Vol. 22, No. 7, 417-27 (July 1961).
In French.
The hyperfine structure of several lines of Lu I and Lu II, emitted by a sample of lutetium containing 74.5% Lu^{176} and 25.5% Lu^{175}, was recorded using a Fabry–Perot spectrometer. From the ratio of intensities of the hyperfine structure components, it is deduced that $I^{176} = 7$, confirming the result of Kaliteevskiĭ and Chaika (Abstr. 13596 of 1959). The ratios of the moments of the two isotopes are:

$$\mu^{175}/\mu^{176} = 0.7109 \pm 0.0050 \text{ and } Q^{175}/Q^{176} = 0.71 \pm 0.01.$$

The value proposed by Steudel, $\mu = +2.0 \pm 0.2\ \mu_N$ is confirmed, but the value of the quadrupole moment must be revised:

$$Q^{175} = (4.0 \pm 0.5).1/(1 - R).10^{-24} = (5.6 \pm 0.6).1/(1 - R')\ 10^{-24}\ cm^2,$$

where R and R' are the Sternheimer corrections for the 6p and 5d electrons, respectively. The results are compared with the predictions of the model of Mottelson and Nillson (Abstr. 3822 of 1959), the ratios of the quadrupole moments indicating that the deformations of the two nuclei are identical.

SPIN AND PARITY OF 4.12 MeV STATE OF Mg^{24}.
See Abstr. 13729

SPINS AND PARITIES OF Ru^{102} LEVELS. See Abstr. 13755

16966 THE PROBLEM OF COMPUTING MOMENTS OF INERTIA OF NUCLEI. S.T.Belyaev.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 672-5 (Feb., 1961).
In Russian.
By using the generalized canonical transformation method, an expression is obtained for the moment of inertia of a nucleus which takes nucleon pairing into account. The result is essentially the same as that obtained previously by Migdal using the Green's function method (Abstr. 9505 of 1960). [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 470-2 (Aug., 1961)].

16967 MAGNETIC MOMENTS OF MIRROR NUCLEI.
D.Kurath.
Phys. Rev. (USA), Vol. 124, No. 2, 552-4 (Oct. 15, 1961).
The sum of the magnetic dipole moments for pairs of mirror nuclei, as calculated with intermediate-coupling functions in the 1p shell, is found to be very insensitive to the degree of spin–orbit coupling. This property can be understood as being due to the rotational nature of the wave-functions, and can also be interpreted in terms of wave-functions from the Nilsson model. Magnetic dipole moments are predicted for those nuclei which have not been measured.

16968 MAGNETIC MOMENT OF N^{13}.
M.Posner, J.L.Snider, A.M.Berstein and D.R.Hamilton.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 173-4 (Sept. 1, 1961).
The magnetic moment of N^{13} produced by proton bombardment of N^{14} has been measured by an atomic beam technique.
L.L.Green

16969 POSSIBLE CORRECTIONS TO NUCLEAR MAGNETIC MOMENTS DUE TO PAIRING FORCES IN NUCLEI. I.
J.Sawicki.
Progr. theor. Phys. (Japan), Vol. 24, No. 1, 213-16 (July, 1960).
Following the method of Migdal (Abstr. 9505 of 1960), these are calculated and the corrections to the direct particle contributions are found to be small. P.K.Kabir

16970 NUCLEAR QUADRUPOLE MOMENTS DETERMINED BY ATOMIC AND MOLECULAR SPECTROSCOPY.
J.Michielsen-Effinger.
J. Chim. phys. (France), Vol. 58, No. 5, 533-44 (May, 1961).
In French.
A tabular summary of the nuclear quadrupole moments of the

nuclides is presented. The configuration of the parent atom or molecule, the method of determination and a bibliography are also given. S.J.St-Lorant

CALCULATION OF NUCLEAR QUADRUPOLE MOMENTS OF METALS. See Abstr. 14207

16971 NUCLEAR QUADRUPOLE MOMENT OF Fe^{57m}. G.Burns.
Phys. Rev. (USA), Vol. 124, No. 2, 524-6 (Oct. 15, 1961).

A value for the nuclear quadrupole moment of the excited state of iron, Q^{57m}, is obtained using published values for eQq/h in the octahedral and tetrahedral sites in $Y_3Fe_2(FeO_4)_3$ (YFe garnet) and in Fe_2O_3, along with recent values for the atomic coordinates in these compounds. The value of Q^{57m} is definitely positive and $\cong +0.4 \times 10^{-24}$ cm^2.

QUADRUPOLE MOMENT OF N^{14}. See Abstr. 17356

16972 NUCLEAR POLARIZATION BY "DOUBLE EFFECT" IN THE PRESENCE OF DIFFUSION WHEN THE ELECTRONIC RESONANCE LINE IS INHOMOGENEOUS. J.L.Motchane and J.Uebersfeld.
J. Phys. Radium (France), Vol. 21, No. 11, 801-2 (Nov., 1960). In French.

Studies the polarization of nuclei of a fluid in contact with a porous paramagnetic solid. E.A.Sanderson

16973 THE SHAPE OF THE ATOMIC NUCLEUS AND ZERO SPIN EXCITED STATES. A.S.Davydov, V.S.Rostovsky and A.A.Chaban.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 134-43 (Sept., 1961).

Collective excited states corresponding to rotation, β- and γ-oscillations of the surface of even nuclei are investigated. The probabilities for E0 transitions between these states and E2 transitions from zero-spin levels are calculated for spherical nuclei and non-spherical nuclei with $\gamma_0 = 0$ as well as $\gamma_0 \neq 0$. It is shown that the parameter γ in the theory of rotational states of non-axial nuclei can be identified with the most probable value of γ_m corresponding to zero oscillations of the nuclear surface about the equilibrium position.

16974 RESONANCE SCATTERING OF GAMMA RAYS BY Te^{124} NUCLEI. A.F.Akkerman, D.K.Kaipov and Yu.K.Shubnyi.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1031-2 (April, 1961). In Russian.

The lifetime of the excited state at 608 keV in Te^{124} was determined from the experimental value of the cross-section for resonance scattering of γ-quanta. The value obtained is compared with the predictions of the single particle model. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 725-6 (Oct., 1961)].

16975 A PHENOMENOLOGICAL MODEL FOR HYPERNUCLEAR BINDING ENERGIES. J.W.Olley.
Austral. J. Phys., Vol. 14, No. 2, 313-17 (June, 1961).

The binding energies were fitted with square and exponential wells of constant depth but whose radii increased with mass number. J.E.Paton

16976 IDENTIFICATION OF HEAVY HYPERNUCLEI FROM K^- CAPTURE BY PRIMARY STAR ANALYSIS. P.E.Schlein and W.E.Slater.
Nuovo Cimento (Italy), Vol. 21, No. 2, 213-34 (July 16, 1961).

Several hypernuclei of $A \geq 7$ were uniquely identified from an analysis of the parent K^- capture reactions. This method has proved of great value in the choice of the correct identity when the decay process offered various alternative interpretations. An example of the decay ${}_{\Lambda}C^{13} \rightarrow \pi^- + N^{13}$, $B_{\Lambda} = (10.8 \pm 0.5)$ MeV was thus identified for the first time. A second example of the decay ${}_{\Lambda}B^{12} \rightarrow \pi^- + 3He^4$, $B_{\Lambda} = (9.9 \pm 0.6)$ MeV is reported, confirming the previous observation of this hypernuclide (Abstr. 13154 of 1960). Some progress is made in resolving the composition of a group of heavy two-body decays. None of the events studied is inconsistent with K^- capture on light nuclei (C, N, O); two events require a two-nucleon capture process.

Energy Levels

16977 REMARKS ON SOME TOPICS IN NUCLEAR SPECTROSCOPY. R.Van Lieshout.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 2, 132-51 (1961).

This article contains a general review of the field of nuclear spectroscopy. Topics discussed include single-particle model, collective rotations and vibrations, the energy gap and gross structure of nuclear levels. L.L.C

16978 CENTRE-OF-MASS INVARIANCE AND THE ENERG SHIFT IN THE NUCLEAR DIPOLE STATE. S.Fallieros.
Nuclear Phys. (Internat.), Vol. 26, No. 4, 594-607 (Sept., 1961).

A relation is obtained between the magnitude of the energy shift in the nuclear dipole state and the particle-shell interactic energy which characterizes the single-particle excitations. It i found that the ratio of these two quantities is approximately independent of the strength, the detailed shape and the odd-state coefficients of the nuclear two-body force. A value of about one half is obtained for this ratio if the customary values for the ev state nuclear force parameters are used.

ZERO SPIN EXCITED STATES. See Abstr. 16973

16979 A CONTRIBUTION TO THE EXPERIMENTAL STUI OF EXCITED LEVELS IN SOME RADIOACTIVE NUCLEI. A.Knipper.
Ann. Phys. (France), Vol. 6, No. 1-2, 211-63 (Jan.-Feb., 1961). In French.

A thesis dealing with an experimental study of excited nucl Upper limits for the lifetimes of excited levels in AcC''(Tl^{207}), Ni^{60}, O^{16} are given. Excited levels of Cd^{110} are studied in the second of the thesis. In the third and final section aligned samples are to study decay schemes of Co^{57}. The nuclear alignment of Ce^{14} and Ce^{139} are also discussed. R.H.Th

16980 IDENTIFICATION OF DOUBLET STATES AT 5.16 IN B^{10}. E.L.Sprenkel, J.W.Olness and R.E.Segel.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 174-7 (Sept. 1, 1961).

The 5.16 MeV state in B^{10} is shown to decay by the emissi of a 3.42 MeV γ-ray to the 1.74 MeV state in B^{10} in addition to well-known decay modes of the state. This 3.42 γ-ray is reson in the $Li^6(\alpha,\gamma)B^{10}$ reaction at 1.2 MeV energy and the propertie the level are obtained. It is suggested that there is a doublet i at 5.16 MeV and that this observation removes disagreements i other reactions involving these states. L.L.C

16981 C^{12} LEVEL STRUCTURE IN THE EXCITATION REGION 20.5-26.5 MeV. G.J.F.Legge and I.F.Bubl
Nuclear Phys. (Internat.), Vol. 26, No. 4, 616-33 (Sept., 1961).

The absolute cross-section for total neutron emission in th reaction B^{11} (p,n) C^{11} was found by an activation technique over range of proton energies 4.9 to 11.4 MeV. The excitation funct for this reaction is plotted in 10 keV steps of proton energy. Eleven resonances are resolved at proton energies of 5.065, 5.48, 6.03, 7.28, 7.73, 8.25, 8.64, 9.24, 9.79, 10.13 and 10.91 Me None of the resonances has an estimated width at half height of than 70 keV. The cross-section has a maximum value of 430 ± 45 mb at 6.03 MeV, at which energy the excitation functi is fitted by assuming the existence of a single-particle state ha $J^{\pi} = 4^-$. Direct interaction and compound system modes of rea appear to contribute to the cross-section roughly in the ratio 2 throughout the region of excitation covered. There is some evidence for interference between the two modes. A comparis with other experimental results is made.

ENERGY LEVELS IN Cd^{114}. See Abstr. 17119

16982 LEVELS IN Co^{59}. B.N.Subba Rao.
Proc. Indian Acad. Sci. A, Vol. 52, No. 3, 130-4 (Sept., 1960).

The β-transition from Fe^{59} leading to the 1430 keV excited state of Co^{59} was observed. In addition to the γ-rays known to a 70 keV γ-ray and its corresponding conversion line were obs Its conversion coefficient of α(total) = 0.6 ± 0.45 requires an a momentum change of not more than two units.

6983 EVIDENCE FOR CHARGE INDEPENDENCE IN MEDIUM WEIGHT NUCLEI. J.D.Anderson and C.Wong.
. Rev. Letters (USA), Vol. 7, No. 6, 250-2 (Sept. 15, 1961).
The energy spectrum of the neutrons from the $V^{51}(p,n)Cr^{51}$ tion has been measured by a time-of-flight method for proton gies between 9 and 13.3 MeV. It is concluded that a group of rons corresponding to an excitation in Cr^{51} of 6.5 MeV is due to direct pn reaction in which the Cr^{51} is formed in the analogue of ground state of V^{51}. L.L.Green

6984 ENERGY LEVELS IN ^{166}Er NUCLEUS.
E.Bożek, H.Niewodniczanski, S.Ogaza, S.Szymczyk Yu.V.Norseev.
phys. Polon, (Poland), Vol. 20, No. 3, 257-66 (1961).
The level scheme of Er^{166} was investigated using the decay of ^{166} (7.7 hr) in equilibrium with Yb^{166} (58 hr). Gamma—gamma cidence experiments were performed and a new level scheme Er^{166} is proposed with levels at 80, 264, 788, 862, 957, 1536,) and 2354 keV and spin and parity assignments.

LEVEL SCHEME OF Eu^{153}. See Abstr. 13733

ENERGY LEVELS OF Gd^{156}. See Abstr. 17021

LEVELS IN Hf^{177}. See Abstr. 17027

6985 HALF-LIFE OF THE 595 keV EXCITED LEVEL OF In^{115}.
rodetzky, R.Manquenouille, R.Richert and A.Knipper.
hys. Radium (France), Vol. 21, No. 5, 439-42 (May, 1960).
rench.
Low and Mean Energy Nuclear Physics Colloquium, Grenoble,) (see Abstr. 12029 of 1961). The transition probability of the tric quadrupole radiation in the decay of the 595 keV level ^{115} is found to be greater by a factor 2 than the single particle mate. The half-life of this level is $T_{1/2} = (5.9 \pm 0.3)\ 10^{-9}$ sec.

THE LEVEL SCHEME OF Pb^{208}. See Abstr. 17061

6986 Li^6 PLUS NEUTRON CONFIGURATION IN Li^7.
F.C.Khanna, Y.C.Tang and K.Wildermuth.
s. Rev. (USA), Vol. 124, No. 2, 515-19 (Oct. 15, 1961).
Energy levels of Li^7 are examined in the Li^6 cluster plus tron configuration. The main purpose is to determine whether sitive-parity level does exist at 6.54 MeV as indicated by e experiments. The results show that the formation of such ate is not favoured by the fundamental nucleon—nucleon raction which yields the deuteron binding energy and explains s- and p-wave scattering data. The energy of the $^2P_{5/2}$ state also computed. The resultant value of -27.2 MeV is in fair eement with the experimental value of -31.7 MeV.

6987 THE ENERGY LEVELS OF THE MAGNESIUM ISOTOPES OF MASS 25 TO 28.
nds, H.Marchant and R.Middleton.
. Phys. Soc. (GB), Vol. 78, Pt 4, 473-90 (Oct., 1961).
The energy levels of the magnesium isotopes of mass 25 to 28 usive were measured with a broad-range magnetic spectrograph g a variety of deuteron- and triton-induced nuclear reactions. following is a list of the reactions used to study each magnesium ope together with the number of levels observed below a icular excitation energy:

Mg^{25}	$Mg^{24}(d,p)Mg^{25}$	54 levels below 7.64 MeV
	$Al^{27}(d,\alpha)Mg^{25}$	54 levels below 7.64 MeV
Mg^{26}	$Mg^{25}(d,p)Mg^{26}$	49 levels below 8.617 MeV
	$Mg^{24}(t,p)Mg^{26}$	63 levels below 9.370 MeV
	$Al^{27}(t,\alpha)Mg^{26}$	87 levels below 10.515 MeV
Mg^{27}	$Mg^{26}(d,p)Mg^{27}$	18 levels below 5.017 MeV
	$Mg^{25}(t,p)Mg^{27}$	42 levels below 7.031 MeV
Mg^{28}	$Mg^{26}(t,p)Mg^{28}$	19 levels below 6.759 MeV

ground state Q-values of the above reactions were also sured.

16988 LEVEL STRUCTURE OF Nd^{144}.
K.Sugiyama, A.Furusawa, S.Hayashibe and M.Kimura.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1538-43 (Aug., 1961).
The energies and spins of lower excited levels in Nd^{144} were established by studies of the beta decay of Ce^{144}—Pr^{144} and the electron capture decay of Pm^{144}. The experiments included the energy and relative intensity measurements, and directional correlation measurements of γ-rays by several NaI(Tl) scintillation counters. The level of Nd^{144} is populated at 695 keV and 2190 keV from the decay of Pr^{144}, and at 695 keV, 1310 keV, and 1780 keV from the decay of Pm^{144}. The levels at 1220 keV and 1560 keV which were found by the neutron capture γ-ray measurements could not be found in both decays in the limit of about 1%.

16989 A 7.02 MeV LEVEL IN Ne^{20}.
A.E.Litherland, M.A.Clark and H.E.Gove.
Canad. J. Phys., Vol. 39, No. 8, 1249-51 (Aug., 1961).
An α-particle group corresponding to the formation of an Ne^{20} level at 7.02 MeV in the $C^{12}(C^{12},\alpha)Ne^{20}$ reaction was observed using a solid-state counter. Coincidences between this group of α-particles and γ-rays detected in a NaI crystal were observed and the γ-ray decay modes of this new state were obtained. L.L.Green

16990 LIFETIMES OF THE LOW-LYING LEVELS IN Ne^{20}.
M.A.Clark, H.E.Gove and A.E.Litherland.
Canad. J. Phys., Vol. 39, No. 8, 1241-2 (Aug., 1961).
The lifetimes of the 1.63, 4.25, 4.97 MeV levels in Ne^{20} were measured by the Doppler shift attenuation method in the $C^{12}(C^{12},\alpha)Ne^{20}$ reaction. L.L.Green

16991 MAGNETIC SPECTROMETER MEASUREMENTS OF LEVELS OF Ne^{20}. E.Almqvist and J.A.Kuehner.
Canad. J. Phys., Vol. 39, No. 8, 1246-8 (Aug., 1961).
The energies of the α-particles from the $C^{12}(C^{12},\alpha)Ne^{20}$ reaction were measured using a magnetic spectrometer at 0^0, 10^0 and 50^0 in the laboratory system. Evidence for several new levels in Ne^{20} is presented. L.L.Green

16992 THE FIRST EXCITED LEVELS OF PLATINUM 190.
J.Jastrzebski and P.Kilcher.
J. Phys. Radium (France), Vol. 22, No. 8-9, 525-7 (Aug.-Sept., 1961).
In French.
The decay of Au^{190} was investigated with an intermediate image β-ray spectrometer and with scintillation techniques. The ratio $r = B(E2\ ;\ 2' \rightarrow 2)/B(E2\ ;\ 2' \rightarrow 0)$ was determined by measurement of conversion electron intensities. Comparison of the energies for the first three excited levels and the r values is given for different even-even Pt nuclei.

16993 STUDY OF THE 11.2 MeV LEVEL IN Si^{28} BY RESONANT SCATTERING AND ABSORPTION.
A.Bussiere De Nercy.
J. Phys. Radium (France), Vol. 22, No. 2, 119-21 (Feb., 1961).
In French.
The resonant scattering of γ-rays of maximum energy 16 MeV from silicon was studied. The spectrum of scattered γ-rays indicates a level at 11.2 ± 0.05 MeV in Si^{28}. The angular distribution of the scattered γ-rays was observed and indicates a predominantly dipole character corresponding to a spin J = 1 for this level. L.L.Green

16994 EXCITED LEVELS OF Si^{30}.
A.M.Romanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1540-1 (Dec., 1960).
In Russian.
The Si^{30} level scheme excited in the $Al^{27}(\alpha,p)Si^{30}$ reaction is determined. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1072-3 (June, 1961)].

16995 MEASUREMENT OF THE MEAN LIFE OF THE FIRST EXCITED STATE OF Na^{23}.
B.Ambroży, A.Faudrowicz, A.Jasiński, J.Kownacki, H.Lancman and J.Ludziejewski.
Acta phys. Polon. (Poland), Vol. 20, No. 7, 537-44 (1961).
Measured using resonance fluorescence technique. Ne^{23}, obtained from the Ne^{22} (n,γ) Ne^{23} reaction by irradiating neon in the reactor, was used as the source. The value of the mean life was found to be $\tau = (1.5\ ^{+0.3}_{-0.2}) \times 10^{-12}$ sec.

16996 NUCLEAR ENERGY LEVELS OF Na^{24} IN THE REGION FROM 630 TO 860 keV. C.T.Hibdon.
Phys. Rev. (USA), Vol. 124, No. 2, 500-14 (Oct. 15, 1961).

An investigation of the nuclear level structure of Na^{24} for neutron energies in the range from 630 to 860 keV revealed the presence of 73 levels distributed throughout the range. Each of the two previously known large peaks was found to be composed of a set of levels. These levels are attributable to values of J up to 7 for the first peak and up to J = 6 for the other one. No s-wave levels were identifiable in this region and it is doubtful that any p-wave levels are present. A set of parameters was determined for the levels by a best fit to the data. These levels were then grouped with those up to 630 keV (Abstr. 9534 of 1960; 8626 of 1961) to obtain a combined total of 230 levels up to 860 keV. The parameters of these levels show the following distributions: (a) an approximate exponential distribution for the level spacings, (b) an approximate exponential or Porter–Thomas distribution for the neutron widths with a tendency to favour the latter, and (c) a distribution of the angular momenta which agrees with the theoretical distribution given by Bloch. Reasonable values of the strength functions were obtained for s- and p-wave levels (0.035 and 0.27, respectively) but the values for $l \geq 2$ appear to be much too large. A plot of the number of levels having energies $\leq E_n$ as a function of E_n shows fluctuations about a linear trend, with no bending away from this trend at high energies to indicate a general missing of levels.

16997 LEVEL STRUCTURE OF Sn^{118} AND Sn^{120} FROM THE DECAY OF Sb ISOTOPES.
H.H.Bolotin, A.C.Li and A.Schwarzschild.
Phys. Rev. (USA), Vol. 124, No. 1, 213-23 (Oct. 1, 1961).

The decays of 5 hr Sb^{118} and 6 day Sb^{120} were studied. The spins, parities, and multipole orders of the transitions in both Sn isotopes are characterized by 7-(E2)5-(E1)4+ (E2)2+ (E2)0+. Level ordering in both isotopes was determined to differ from the previously accepted order. The spins and multipole order assignments were determined from angular correlation and internal conversion measurements in Sn^{118} and from a reinterpretation of similar experimental results by Ikegami for Sn^{120} (Abstr. 622 of 1961). All β-decay is directly to the 7- states. The levels are at 2.57, 2.32, 2.28, and 1.23 MeV in Sn^{118} and 2.50, 2.30, 2.21, and 1.18 MeV in Sn^{120}. Half-lives determined using delayed coincidence techniques were as follows: (7-), $(2.3 \pm 0.1) \times 10^{-7}$ sec; (5-), $(2.0 \pm 0.3) \times 10^{-8}$ sec in Sn^{118}; and (7-), $(1.12 \pm 0.10) \times 10^{-5}$ sec; (5-), $(5.2 \pm 0.4) \times 10^{-9}$ sec in Sn^{120}. Reduced transition probabilities are compared with current theories. No crossover transitions were found in either decay except for a weak 1.090 MeV E3 transition from the 5– to 2+ levels in Sn^{118} which has a reduced transition probability close to single-particle speed. Triple coincidence experiments determined a β^+ to capture ratio of $(1.6 \pm 0.1) \times 1)^{-3}$ in the Sb^{118} decay yielding an inferred transition energy of 1.32 MeV.

16998 THE SECOND EXCITED STATE OF Sn^{120}.
M.Kawamura, A.Aoki and H.Ikegami.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1493-7 (Aug., 1961).

The directional correlation and the polarization-direction correlation of the 1.03-1.17 MeV $\gamma-\gamma$ cascade in Sn^{120} were measured. It is found that the spin and the parity of the second excited state of Sn^{120} is 4 and even, respectively.

16999 PARTIAL TRANSITION WIDTHS FOR THE LEVELS OF SPIN J = 1 IN W^{184} AND Pt^{198} EXCITED BY [RESONANCE] NUCLEAR CAPTURE.
J.Julien, C.Corge, V.-D.Huynh, F.Netter and J.Simic.
J. Phys. Radium (France), Vol. 21, No. 5, 423-5 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). The relative transition probabilities to the ground state and to the first excited levels show some fluctuations from level to level. In order to analyse the distributions of the partial radiation width, it was assumed, as Porter and Thomas did (Abstr. 1619 of 1957), that the correct distribution is χ^2 one.

17000 EXCITED STATES OF ^{64}Zn.
M.J.Kenny and D.E.Caro.
Austral. J. Phys., Vol. 14, No. 2, 242-9 (June, 1961).

The reaction $Cu^{63}(p,n)Zn^{63}$ was studied at bombarding energies between 5 and 11.5 MeV using an activation technique with good energy resolution. Previously unknown levels in Zn^{64} at excitation energies of approximately 13.3_7, 13.7_8, 14.1_2, 14.3_1, 14.9_0, 15.1_8, 15.6_1, and 15.7_7 MeV were found. It is shown that six of these l and the observed absence of levels in some energy regions, can accounted for in terms of Nilsson's calculations for the single-particle states of a deformed nucleus. If this interpretation is correct, the deformation of Zn^{64} must be negative, at least in it highly excited states.

17001 NUCLEAR INTERACTIONS IN THE $P_{1/2}-G_{9/2}$ CON URATIONS.
V.K.Thankappan, Y.R.Waghmare and S.P.Pandya.
Progr. theor. Phys. (Japan), Vol. 26, No. 1, 22-8 (July, 1961).

Zr^{90} is a good example for the study of T=1 levels in the $p_{1/2}-g_{9/2}$ subshells and has recently been explored by several authors. Here earlier calculations of Thankappan and Waghma (Abstr. 625 of 1961) are extended and analysed in detail. It is that a simple central two-body interaction can be constructed will give correctly the energy levels of the $(g_{9/2})^2$ configuration and hence also the levels of a $(g_{9/2})^n$ configuration. However, same interaction fails to give correctly the levels of the other figurations $(p_{1/2})(g_{9/2})$ and $(p_{1/2})^2$. This simple two-body nucle interaction is thus shown to be configuration dependent. It is p out that experimental identification of the as yet unobserved 4 would be very helpful for further elucidation of this phenomeno The results are compared with those of the other authors.

17002 EXPERIMENTAL DEMONSTRATION OF DOUBLE QUANTUM EMISSION IN THE $0^+ - 0^+$ TRANSITION Zr^{90}. H.Langhoff and H.H.Hennies.
Z. Phys. (Germany), Vol. 164, No. 2, 166-73 (1961). In Germa

The detection was attempted with a scintillation coincidenc spectrometer of double quantum emission in the $0^+ - 0^+$ transi of the first excited level of Zr^{90}. An effect probably due to dou quantum emission is detected giving $2 \cdot 10^{-3}$ for the decay const The level is obtained by β-decay of Y^{90}. From measurement o positron annihilation radiation it is shown that $(3,4 \pm 0.4) \cdot 10^{-5}$ pairs of dc-excitation of this level are created per β-decay of

NUCLEAR DECAY RADIOACTIVITY

17003 SIMULTANEOUS ESTIMATION OF SEVERAL RA ACTIVE NUCLIDES. C.W.Gilbert.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 230-2 (Oct., 1960).

Describes a method for determining the activity of a parti isotope in a sample containing many other isotopes. In princip in a sample containing n radioactive periods, measurements a made with n different detectors each having different sensitivi for the emitted radiations. R.H.T

17004 LIQUID SCINTILLATION COUNTING OF C^{14} PLAS PROTEINS USING A STANDARD QUENCHING CUR
M.Toporek.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 4, 22 (Oct., 1960).

Describes how the radioactivity of C^{14}-labelled protein sa may be determined by dissolving in hyamine and counting in a scintillation counter. Correction for the quenching effect of th solved protein on the counting rate was made by determining t correction curves, one for normal human serum protein the ot for bovine albumen. R.H.T

CRITERIA FOR EVALUATING COLLIMATORS USED IN "VIVO" DISTRIBUTION STUDIES WITH RADIOISOTOPES.
See Abstr. 15366

17005 CONTINOUS SUPERVISION OF THE SEDIMENTA OF "HOT PARTICLES" FROM THE ATMOSPHER
H.Meurers.
Atomkernenergie (Germany), Vol. 5, No. 11, 416-8 (Nov., 196 In German.

A complete description is given of a measuring procedur the study of "hot particles". The black dots on the autoradiog taken of adhesive sheets were classified as to "size" by photo metric means. The results of experiments done in 1959 and t

ning of 1960 show a correlation between the density of the and the total radio-activity. This procedure is used to form jective definition of the measuring data, so that it is quite cable for an extensive check under established conditions. order of the detection limit can be given from a gauging test. basic problems of this procedure are well known.

IRON-55 FROM NUCLEAR DETONATIONS.
7006 Rama, M.Koide and E.D.Goldberg.
re (GB), Vol. 191, 162 (July 8, 1961).
The present content of Fe^{55} in the oceans was determined by acting and assaying the iron concentrated in the livers and hearts na fish. The Fe^{55} (an X-ray emitter with a half-life of 2.6 yr) produced during nuclear bomb detonations by (n, 2n) and (n, γ) tions on the Fe^{56} and Fe^{54} present in the structures associated nuclear bombs. The activity was measured in a proportional ter. The specific activity of the samples, in February 1961, 82 000 d.p.m. g^{-1} of iron, a level insufficiently high to titute a health hazard. A measure of atmospheric fallout e oceans was obtained by assaying rain from San Diego for activity. The yield in February 1961 was 0.8 d.p.m./l. indicated that the present introduction of atmospheric fallout nall compared with the total inventory in the ocean. One metre infall introduces only about 0.08 d.p.m. of Fe^{55} anually per cm^2 eanic area and the Fe^{55} inventory in the Pacific is calculated of the order of 330 d.p.m. cm^{-2} of oceanic area.
C.F.Barnaby

GAMMA-ACTIVE FALL-OUT IN ONTARIO 1958-60.
7007 K.G.McNeill, O.A.D.Trojan and D.J.Dawson.
d. J. Phys., Vol. 39, No. 7, 1010-16 (July, 1961).
Measurements were made of the Cs^{137} content of man and of and of the Zr^{95} and Cs^{137} activity of airborne dust. They show the Cs^{137} content of man went through a maximum of 67 $\mu\mu$c/g K e fall of 1959, and that the Cs^{137} content of milk reached a low 5 $\mu\mu$c/g K in September 1960. The results suggest strato- ric and tropospheric residence times of 2 years and 2 months ectively.

RADIOACTIVITY ASSOCIATED WITH UNDERGROUND LEAR EXPLOSIONS. See Abstr. 15217

MEASUREMENTS OF LOW LEVEL ENVIRONMENTAL
7008 RADIATION BY MEANS OF GEIGER MÜLLER
NTERS WITH OBSERVATIONS IN THE AMSTERDAM AREA.
W.Aten, Jr, I.Heertje and W.M.C.de Jong.
ica (Netherlands), Vol. 27, No. 9, 809-20 (Sept., 1961).
Commercially available gamma counters of the Geiger–Müller were equipped with tin and Perspex filters to reduce the depend- of the sensitivity (in counts per microröntgen) on the energy. rvations were made on the level of the environmental radiation d around Amsterdam. The radiation level is found to be some- — but not very much — lower than has been observed under lar conditions in other countries. To interpret these results ral γ-emitting radionuclides were found in samples of building rials.

ANGULAR CORRELATION THEORY WITH JACOB–
7009 WICK METHOD. M.Micu.
phys. Polon. (Poland), Vol. 20, No. 2, 157-9 (1961).
The angular correlation formula for decays of the type $B+d_1$, $B \rightarrow C+d_2$ is deduced by using the development of the ê-wave suggested by Jacob and Wick (Abstr. 12531 of 1959). lack of Racah coefficients and of summations over the orbital lar momentum quantum numbers makes the expression given he angular correlation simpler than the well-known expression evons and Goldfarb (1957).

NEW ANTIMONY ISOTOPES.
7010 I.P.Selinov, Iu.A.Grits, D.E.Khulelidze, E.E.Baroni, Bliodze, A.G.D'Omin and Iu.P.Kuschakevich.
naya Energiya (USSR), Vol. 5, 660 (1958). In Russian. English lation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4, 76 , 1960).
The bombardment of the separated isotopes Sn^{112} and Sn^{114} by eV deuterons yielded two unknown activities. Chemical ration of the new radioisotopes indicated that they were ably produced by the reactions $Sn^{112}(d,n)Sb^{113}$ and $Sn^{114}(d,n)Sb^{115}$. is continuing to establish a more accurate decay scheme for ew isotopes. B.Brown

THE HALF-LIFE OF LONG-LIVED LUTETIUM-176.
17011 A.McNair.
Phil. Mag. (GB), Vol. 6, 851-6 (July, 1961).
The half-life of the odd-odd naturally occurring isotope Lu^{176} is shown to be $(3.6 \pm 0.1) \times 10^{10}$ years, from independent measurements both of the rate of gamma and of electron emission.

DETERMINATION OF THE DEFORMATION AND
17012 QUADRUPOLARIZATION OF ALPHA-ACTIVE NUCLEI FROM THE ENERGY AND ANGULAR DISTRIBUTIONS OF THE ALPHA PARTICLES. V.G.Nosov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1660-7 (Dec., 1960). In Russian.
The theory of the α decay of nonspherical nuclei developed previously by the author is employed to treat the experimental data on the relative intensities of the fine structure lines in the α radiation, the half-lives, and the angular distributions of the α particles emitted by oriented nuclei. The dependence of the nuclear deformation on the atomic weight in the region $A > 220$ is deduced from fine structure data. It is shown that, by taking into account the effect of these deformations on the half-lives, it is possible to remove the anomalies in the variation of the radii of α-active nuclei which result from the comparison of the old theories of α decay with experiment. The quadrupolarization of the parent U^{233} nuclei was determined in the corresponding experiments from the angular distribution of the α particles. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1159-64 (June, 1961)].

ALPHA DECAY OF THE Bi^{210m} ISOMER.
17013 L.I.Rusinov, Yu.N.Andreev, S.V.Golenetskii, M.I.Kislov and Yu.I.Filimonov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1007-15 (April, 1961). In Russian.
The long-lived α-active isomer Bi^{210m} was studied. Lines with energies of 4930 ± 10 keV (60%), 4890 ± 10 keV (34%), 4590 ± 10 keV (5%), and 4480 ± 15 keV (~0.5%) were detected in the α-spectrum. Gamma radiation from the daughter nucleus Tl^{206} was detected and studied. Gamma rays of energies 262, 301, 340 and 610 keV were found. The existence of the coincidences α4930–γ262, α4890–γ301, α4590–γ610, and α4590–γ340 keV was established. The γ-transition multipolarities were determined from the internal-conversion electron spectrum and were found to be E2 for 262 keV and M1 for 301 keV. The measured lifetimes of the Tl^{206} levels are τ(262 keV) = 1.7×10^{-9} sec and τ(301 keV) = 4.6×10^{-9} sec. A decay scheme for Bi^{210m} is constructed on the basis of the experimental data. It is shown that RaE is the ground state of Bi^{210} and the long-lived Bi^{210m} is its excited state (250 keV) with a partial half-life of $\sim 5 \times 10^{10}$ years relative to the isomeric transition. The experimental data are compared with the theoretical calculations of the energy states of the Tl^{206} and Bi^{210} nuclei. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 4, 707-13 (Oct., 1961)].

THE SPECIFIC α-ACTIVITY OF Pu^{239} AND Pu^{240}.
17014 Ia.P.Dokuchaev.
Atomnaya Energiya (USSR), Vol. 6, 74 (1959). In Russian. English translation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4, 195 (Feb., 1960).
The specific α-activity of Pu^{239} and Pu^{240} was determined from measurements made on 12 plutonium samples having varying isotopic compositions. Details of the experimental technique are given and the following results were obtained: 1μg of Pu^{239} gives 136 200 ± 200 α-decays/min, corresponding to a half-life of 24, 390 ± 30 yr, 1μg of Pu^{240} gives 500 000 ± 4000 α-decays/min, corresponding to a half-life of 6620 ± 50 yr. These half-lives agree reasonably with other workers' results. B.Brown

CORRECTIONS FOR BACKSCATTERING AND ENERGY
17015 RESOLUTION IN BETA SPECTROSCOPY BY SCINTILLATION DIRECTORS. G.Bertolini, F.Cappellani and A.Rota.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 107-10 (Oct., 1960).
The correction for phosphor backscattering and energy resolution is applied to plastic detectors. The application of the correction terms to the beta spectra of Tl^{204} and Tm^{170} gives satisfactory results.

THEORY OF BOUND-STATE BETA DECAY.
17016 J.N.Bahcall.
Phys. Rev. (USA), Vol. 124, No. 2, 495-9 (Oct. 15, 1961).
The theory of beta-decay processes in which an electron is

created in a bound atomic state is developed in the allowed approximation. The correlations and total decay rate are calculated with the renormalized V–A theory and the results are valid for atoms of arbitrary electronic configuration. The relative probability of bound-state to continuum-state decay is shown to be independent of nuclear matrix elements; some bound-state decay rates are presented that were calculated by making use of this fact. The possibility of experimentally detecting bound-state decay is also briefly examined. The beta decay of nuclei in stellar interiors is discussed and a number of examples are presented for which bound-state decay is more likely than continuum-state decay under the conditions that obtain in stellar interiors.

17017 THE β-DECAY OF HIGHLY DEFORMED NUCLEI. V.G.Solov'ev.
Dokl. Akad. Nauk SSSR, Vol. 137, No. 6, 1350-3 (April 21, 1961). In Russian.

Using a superfluid model for the nucleus, the general rules for the corrections to the β-decay scheme are worked out, both for ground and excited states of a highly deformed nucleus. Further conditions for the classification of β-decay probabilities are calculated. The role of these corrections is studied in terms of log ft for β-transitions for various types of nuclei. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 4, 346-8 (Oct., 1961)]. G.Martelli

17018 EXPERIMENTAL AND THEORETICAL REMARKS ON THE DOUBLE β-DECAY.
G.F.Dell'antonio and E.Fiorini.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 1, 132-93 (1960).

The present status of the theory and experiments on double β-decay is reviewed. Firstly an outline is given of the theory of the Fermi interaction, emphasizing those features which are important for double β-decay. The process itself is then considered and approximate formulae are derived for the transition amplitudes with and without the emission of neutrinos. The difficulties of estimating the nuclear matrix elements are emphasized, and the approximations made in the process lead to uncertainties of the order $10^{\pm 2}$ in the transition rate. An account is then given of the experiments that have been made, grouped according to whether counters, cloud chambers, nuclear emulsions or chemical separation methods were used. After each group a brief critical comment on its merits is made. The selection of suitable transitions is then considered taking account of energy release and the spins of the nuclear states. Energy level diagrams are given of 15 most suitable transitions for double β-decay and of 17 most suitable transitions for double electron capture, electron capture–positron emission and double β^+-decay. A table is then given comparing the experimental limits with the theoretical predictions. Finally, the possibility of performing a conclusive experiment is briefly discussed. A.Ashmore

17019 AN EXPLANATION OF THE ANOMALIES IN β^- AND β^+ SPECTRA BY AN UHLENBECK–KONOPINSKI TYPE COUPLING. C.Chahine and B.Jouvet.
C.R. Acad. Sci. (France), Vol. 253, No. 6, 945-7 (Aug. 7, 1961). In French.

It is shown that it is possible to account for the anomalies in the β-spectra of Gamow–Teller transitions by introducing an additional coupling term

$$K_A \bar{p}\gamma_\mu\gamma_5 N\bar{e}(1+\gamma_5)\theta_{\mu\nu}$$

into the interaction Hamiltonian, with $K_A/F_A < 0$, where F_A is the Fermi axial vector coupling constant. S.J.St-Lorant

17020 COMPARISON OF THE BETA SPECTRA OF B^{12} AND N^{12}. T.Meyer-Kuckuk and F.C.Michel.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 167-9 (Sept. 1, 1961).

Measurements made of the deviations from the allowed shape of the beta spectra of B^{12} and N^{12} agree with the predictions of the conserved vector current theory. An important uncertainty is the estimated value used for the 7.6 MeV branching ratio in the decay of N^{12}. R.H.Thomas

17021 DECAY SCHEME OF Eu^{156}.
K.S.Y.Ambiye, S.D.Bhagwat, M.C.Joshi, R.P.Sharma and B.N.Subbarao.
Proc. Indian Acad. Sci. A, Vol. 52, No. 4, 157-64 (Oct., 1960).

The 15 days decay activity of Eu^{156} was studied using an intermediate image β-ray spectrometer and β–γ, β–e and γ–γ coincidence techniques. The β-groups, β_1 = 2450, β_2 = 1180, β_3 = 720 and β_4 = 480 keV and the γ-rays (in keV) at 89, 201, 630, 710, 930, 1050, 1140, 1250, 1460, 2050 and 2180 were identified. From coincidence studies, energy levels in Gd^{156} are proposed at 89, 290, 1360, 1540, 1840, 2050 and 2180 keV.

17022 SEARCH FOR A β^- BRANCH IN I^{124}. C.M.Merrihue.
Phys. Rev. (USA), Vol. 124, No. 1, 208-9 (Oct. 1, 1961).

A mass spectrometric search for a β^- branch in 4.2 day I^{124} was made by examining the isotopic composition of xenon from deuteron-irradiated tellurium. The expected β^- branch, based on nuclear mass data and ft values, is 0.017%. There was good agreement between calculated and measured isotopic composition. No Xe^{124} was detected, so an upper limit of 0.1% was established for this branching.

17023 THE β-SPECTRUM OF In^{114}. H.Daniel and P.Panussi.
Z. Phys. (Germany), Vol. 164, No. 3, 303-7 (1961). In German.

The shape of the In^{114} β-spectrum was measured with a magnetic lens spectrometer. The shape factor was found to be essentially allowed. A least square fit gave the following result for the deviation term b/W: $b = (5 \pm 2)\times 10^{-2}$ mc^2. The stated error is standard deviation only. This result does not agree with the large deviation reported by Langer et al. (Abstr. 8297 of 1958). Additional information is given for the isomeric transition.

17024 THE NONLINEARITY OF FERMI DIAGRAMS [KURIE PLOTS] FOR P^{32}. V.Brabec and M.Vindus
Czech. J. Phys., Vol. 10, No. 8, 614-15 (1960). In German.

Discusses values of the shape factors for the experimental Kurie plots obtained for P^{32}. R.H.Th

17025 DETERMINATION OF THE SPECTRA OF THE AUTOIONIZATION ELECTRONS IN β RADIOACTIV
F.Suzor.
J. Phys. Radium (France), Vol. 21, No. 5, 465-6 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Gren 1960 (see Abstr. 12029 of 1961). Continuous spectra, between and 13 kV, of autoionization electrons are given for 3 radioele Y^{90}, Pr^{143} and Na^{22}, in continuation of work already published o P^{32}, S^{35} and Pm^{147} (Abstr. 5002, 5003 of 1959; 20386 of 1960). disagreement results from comparison with theory; this could be explained by a more significant contribution of the external electronic shells.

17026 RELATIVE MEASUREMENTS ON THE LONGITUD POLARIZATION OF BETA RAYS FROM Na^{24}, Mn^{56} Sb^{122}, Ho^{166} AND Au^{198}.
R.Sosnowski, Z.Wilhelmi and J.Wojtkowska.
Nuclear Phys. (Internat.), Vol. 26, No. 2, 280-5 (Aug., 1961).

The longitudinal polarization of electrons from β-decay of Na^{24}, Mn^{56}, Sb^{122}, Ho^{166} and Au^{198} was compared. The degree of polarization was measured by the asymmetry in the electron scattering in a thin gold foil. Longitudinal electron polarizatio was changed into transverse polarization by means of crossed electric and magnetic fields. The measurements were carried for the electrons with v/c = 0.85. The results for the asymme are as follows: 11.0 ± 0.9% (Na^{24}), 11.1 ± 0.8% (Mn^{56}), 10.1 ± (Sb^{122}), 10.4 ± 0.2% (Ho^{166}) and 9.3 ± 0.3% (Au^{198}). The results suggest that the longitudinal polarization is not identical for th measured beta transitions.

17027 DECAY OF Ta^{177} AND Lu^{177} TO LEVELS IN Hf^{177}. H.I.West, Jr, L.G.Mann and R.J.Nagle.
Phys. Rev. (USA), Vol. 124, No. 2, 527-43 (Oct. 15, 1961).

These decays were investigated with beta-ray spectrometer NaI(Tl) gamma-ray spectrometers, and fast coincidence and a correlation techniques. Energy levels in Hf^{177} are characteriz according to their energy (keV), the Nilsson asymptotic quantu numbers ($Nn_z\Lambda$), the total angular momentum and its compone along the symmetry axis (I,K), and the parity (π) as follows: 0[514 7/2, 7/2–]; 112.97[514 9/2, 7/2–]; 249.7[514 11/2, 7/2–] 321.34[624 9/2, 9/2+]; 447.9[624 11/2, 9/2+]; 420.95[642 3/2, 3 488.8[642 5/2, 3/2+]; 585.8[642 7/2, 3/2+] ; 509.0[512 5/2, 5/2 605.5[512 7/2, 5/2–]; 746.04[633 7/2, 7/2+]; 848.2[633 9/2, 7/ and 1058.38[503 7/2, 7/2, 7/2–]. The levels at 447.9, 488.8, a 585.8 keV are tentative. The spins and parities were uniquely

ed by angular correlation and internal conversion data for the ls at 746.0 and 848.2 keV, if it is assumed that the spins and ties of the levels at 0, 113.0, 249.7, and 321.3 keV are correct etermined from earlier work. For the level at 1058.4 keV the ft e is needed in addition to angular correlation and conversion data rder to determine the spin and parity uniquely. The spins of and Hf^{177} have previously been measured directly as 7/2, and Ta^{177} spin is expected to be 7/2 on the basis of other tantalum pes. The following half-lives were measured: 56.56 hr for , 0.32 nsec for the level at 113.0 keV, and 0. 52 nsec for the 3 keV. The K/L electron capture ratio to the 1058.4 keV level he β^+ /K-capture ratio to the ground state determine the total y energy to be 1166 ± 6 keV.

7028 ONCE-FORBIDDEN BETA SPECTRUM OF Tl^{206}.
D.A.Howe and L.M.Langer.
s. Rev. (USA), Vol. 124, No. 2, 519-24 (Oct. 15, 1961).
The beta spectrum of 4.2 min Tl^{206} was investigated in a 4π tillation spectrometer. The source was in secular equilibrium the 2.6×10^6 yr Bi^{210} parent. The electron distribution was rved to have a nonstatistical form which could be fitted with ce-forbidden pseudovector shape factor. No necessity for the usion of any pseudoscalar contribution was observed. The gy release in the Tl^{206} decay is 1.571 ± 0.010 MeV.

7029 A STUDY OF THE RADIOACTIVE DECAY OF Tm^{168}.
V.Brabec, B.Kracík and M.Vobecký.
h. J. Phys., Vol. 10, No. 12, 969-70 (1960). In Russian.
In a magnetic spectrometer study of Tm sources produced in spallation of Ta by 660 MeV protons, a continuous β^-- spectrum observed in addition to the usual conversion lines. This had a -life approximately the same as that of Tm^{168} but the maximum gy, determined by a Fermi plot, of 940 ± 20 keV is in good ement with that of the β^--spectrum of Tm^{170}. This means that r 19% of the decay of Tm^{168} is through β^--emission to Yb^{168}, or atio of the amounts of Tm^{168} and Tm^{170} produced in the spallation tion is 100: 30. The decay is being studied further. A previous- mentioned conversion line of Tm^{168}, K-304, with electron gy 247 keV was also found. J.E.Gore

7030 THE β^+-SPECTRUM OF Na^{22}.
H.Leutz.
hys. (Germany), Vol. 164, No. 1, 78-82 (1961). In German.
The β^+-spectrum of Na^{22} was measured with a scintillation trometer. To avoid source absorption and scattering effects Na^{22} source was built into the lattice of NaI(Tl) crystals. The rved β^+-spectrum of Na^{22} has a statistical shape. The value ined for the Fierz term b was $(+ 0.8 \pm 6.0) \cdot 10^{-3}\ m_0c^2$, retically shown to be zero.

7031 NEUTRON DEFICIENT ISOTOPES OF TERBIUM WITH HALF-LIFE OF 18 HR.
ána, I.Řezanka, M.Vobecký and V.Hušák.
h. J. Phys., Vol. 10, No. 9, 692-3 (1960).
Preliminary results are given of the investigation of the ities of terbium isotopes with half-lives of about 18 hr. The lum was separated chromatographically from a tantalum target h was irradiated with 660 MeV protons. The activities were sured on a short-lens spectrometer, having a resolving power 6%, and a series of conversion lines and a continuous positron trum were found in the activity with a half-life of about 18 hr. lls of the energies of these lines are given. C.F.Barnaby

7032 INVESTIGATION OF THE RADIATIONS FROM Zn^{63}.
S.S.Vasil'ev, No Sen Chan [No Hsieng Ch'ang] and ..Shavtvalov.
eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 475-6 (Feb., 1961).
ussian.
The β^+- and γ-spectra of Zn^{63}, which possesses a half-life of .6 ± 0.3 min, were investigated. The β^+ spectrum consists of components with end-point energies of 500, 1020, 1400, 1710, 2360 keV. The observed 680, 970, 1350, 1430 and 2300 keV ansitions agree on the whole with the β^+ spectra. [English slation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 331-2 ., 1961)].

7033 ON THE TRIPLE ANGULAR CORRELATION.
V.De Sabbata.
o Cimento (Italy), Vol. 21, No. 4, 659-70 (Aug. 16, 1961).
A general formulation of triple angular correlations is given in order to examine the $\beta-\gamma-\gamma$ correlation in particular and its implications on the symmetry properties of the weak and strong interactions. The invariance for time reversal is especially considered.

17034 TENSOR TYPE ($\int B_{ij}$) COMPONENT IN THE 2.31 MeV β TRANSITION OF Sb^{124}. R.M.Steffen.
Phys. Rev. (USA), Vol. 124, No. 1, 145-9 (Oct. 1, 1961).
The $\beta-\gamma$ directional correlation of the first-forbidden 2.31 MeV β-transition of Sb^{124} and of the 0.603 MeV γ-ray of Te^{124} was measured. The integral $\beta-\gamma$ directional correlation measured at an average β energy, $\bar{W} = 4.8$, is represented by

$$W_{\beta\gamma}(\theta, \bar{W}=4.8) = 1 - (0.390 \pm 0.011)P_2(\cos\theta) + (0.004 \pm 0.013)P_4(\cos\theta).$$

The negligibly small $P_4(\cos\theta)$ term provides additional evidence against a second-forbidden β-transition. The energy dependence of the anisotropy coefficient $A_2(W)$ in the correlation function

$$W_{\beta\gamma}(\theta, W) = 1 + A_2(W)P_2(\cos\theta)$$

was measured. The experimental values of $A_2(W)$ exclude the possibility of a pure $\int B_{ij}$ transition, but give conclusive evidence that the $\int B_{ij}$ matrix element contributes very significantly to the 2.31 MeV β-transition of Sb^{124}. In fact, the directional correlation data are well represented, if

$$CA\int B_{ij} \cong -Cv\int i\vec{\alpha} + \xi\, Cv\int \vec{r} - \xi\, CA\int i\vec{\sigma} \times \vec{r},$$

where $\xi = Z\alpha/2R$.

17035 DETERMINATION OF THE NUCLEAR MATRIX ELEMENTS IN THE 2.31 MeV β TRANSITION OF Sb^{124} THROUGH MEASUREMENT OF THE $\beta-\gamma$(CIRCULARLY POLARIZED) ANGULAR CORRELATION.
P.Alexander and R.M.Steffen.
Phys. Rev. (USA), Vol. 124, No. 1, 150-7 (Oct. 1, 1961).
The degree of circular polarization (P_C) of the 0.603 MeV γ-radiation following the first-forbidden β-transition from the 3^- ground state of Sb^{124} to the 2^+ first excited state of Te^{124} was measured. The dependence of P_C on the angle $\theta_{\beta\gamma}$ between the β and γ momentum vectors was determined. Representative values of $P_C(\theta_{\beta\gamma})$ at some of the angles $\theta_{\beta\gamma}$ measured are $P_C = 0.061 \pm 0.071$ at $\theta_{\beta\gamma} = 105^\circ$, $P_C = 0.349 \pm 0.083$ at $\theta_{\beta\gamma} = 122^\circ$, $P_C = 0.604 \pm 0.054$ at $\theta_{\beta\gamma} = 152^\circ$, and $P_C = 0.373 \pm 0.071$ at $\theta_{\beta\gamma} = 168^\circ$. These values were obtained at $\bar{W} = 4.6$. The 2.31 MeV β-transition of Sb^{124} is known to contain an unusually large contribution from the $\int B_{ij}$ matrix element (which describes the component of the lepton field carrying away two units of angular momentum). The measured $\beta-\gamma$ circular-polarization correlation data, the $\beta-\gamma$ directional correlation, and spectral shape data were analysed by use of a digital computer on the basis of the Kotani parameters Y, x, u, and z. A somewhat generous summary of the final data may be given by $Y = 0.6 \pm 0.3$, $x = -0.055 \pm 0.105$, $u = -0.060 \pm 0.140$, $z = 1$. Values of the nuclear matrix elements are extracted from the ft value of the 2.31 MeV β transition and the measured Kotani parameters, yielding $\int B_{ij}/R = \pm(1.4 \pm 0.2) \times 10^{-2}$, $\int \vec{r}/R = \mp(9.3 \pm 17.6) \times 10^{-4}$, $\int i\vec{\sigma} \times \vec{r}/R = \mp(8.1 \pm 18.9) \times 10^{-4}$, $\int i\vec{\alpha} = \pm(1.6 \pm 0.8) \times 10^{-4}$. R is the nuclear radius of Sb^{124} in units of $\hbar/mc$. The significance of suppression of the matrix elements other than $\int B_{ij}$ is discussed.

17036 MEASUREMENTS OF THE BETA—GAMMA CORRELATION IN THE CIRCULAR POLARIZATION OF γ-RAYS FROM Au^{198} AND Sb^{122}. J.P.Deutsch and P.Lipnik.
J. Phys. Radium (France), Vol. 21, No. 11, 806-7 (Nov., 1960).
In French.
Measurements made of the polarization of the γ-rays from Sb^{122} are described. Calibration of the apparatus was carried out using Au^{198}, pending an absolute measurement. The value of the correlation coefficient was 0.40 ± 0.04, in good agreement with previous results. R.H.Thomas

17037 BETA—GAMMA ANGULAR CORRELATION, IN RESONANCE, IN Kr^{85} AND As^{76}. M.Spighel.
J. Phys. Radium (France), Vol. 21, No. 5, 449-50 (May, 1960).
In French.
Low and Mean Energy, Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). This method is of interest in that it can show the type of interaction for β radioactivity. The 150 keV

level of Rb^{85} was measured by the methods of resonance-scattered γ-rays and delayed coincidence; the half-life = $(5.5 \pm 2.5) \times 10^{-10}$ sec. The 560 keV resonance-scattered γ from Se^{76} was demonstrated, in coincidence with the β of As^{76}. The observed angular correlation allows only certain possibilities for the type of interaction. The different possibilities are examined in the light of recent experimental results.

17038 UPPER LIMIT TO THE LIFETIME OF THE 35_1 keV EXCITED STATE OF ^{143}Pr.

S.Gorodetzky, R.Manquenouille, R.Richert and A.Knipper.
C.R. Acad. Sci. (France), Vol. 253, No. 3, 428-9 (July, 1961).
In French.

It is reported that the time resolution curve for the $\beta-\gamma$ coincidence involving the 35_1 keV state in Pr^{143} is no different from the experimental resolution of the apparatus. It is considered that the lifetime of this state must then be less than 1×10^{-10} seconds. L.L.Green

17039 DECAY SCHEME OF ^{212}Pb.

M.Giannini, D.Prosperi and S.Sciuti.
Nuovo Cimento (Italy), Vol. 21, No. 3, 430-41 (Aug. 1, 1961).

Some experimental results concerning $Pb^{212} \rightarrow Bi^{212}$ decay are reported. The investigation of the Pb^{212} decay scheme is of some interest because until now it is not known whether or not the shell model holds in the lead region boundary. Coincidence spectra and $\gamma-\gamma$ angular correlations were employed in order to measure the intensities of weakest transitions, and to make spin assignments. A decay scheme is proposed. Further, the doubtful existence of a 177 keV γ-ray is unambiguously demonstrated.

17040 DECAY OF NEODYMIUM-147.

M.R.Gunye, R.Jambunathan and B.Saraf.
Phys. Rev. (USA), Vol. 124, No. 1, 172-7 (Oct. 1, 1961).

The decay was investigated using scintillation spectroscopy and coincidence technique. The following sequences of gamma emission were uniquely established: 91 keV gamma ray is in coincidence with 120, 199, 277, 322, 400, 442, and 599 keV gamma rays; 120 keV gamma ray with 322 and 413 keV gamma rays; 199 keV gamma ray with 400 and 491 keV gamma rays; 277 keV gamma ray with 322 and 413 keV gamma rays; and 310 keV gamma ray with 322 and 413 keV gamma rays. On the basis of these gamma–gamma sequences, the levels of Pm^{147} at 91, 413, 491, 533, 690, and 723 keV above the ground state are unambiguously established. A critical analysis of the observed coincidence spectra shows that the levels at 182 and 230 keV, suggested by other workers, either do not exist or, if they exist, are not populated by any beta transition of intensity more than 1 % or by any gamma transition from other higher energy levels, of intensity more than 0.1%.

17041 DIRECTIONAL CORRELATION OF GAMMA TRANSITIONS IN PROMETHIUM-147.

B.Saraf, R.Jambunathan and M.R.Gunye.
Phys. Rev. (USA), Vol. 124, No. 1, 178-82 (Oct. 1, 1961).

The angular correlations of five different gamma-ray cascades, involving the states of Pm^{147} and excited in the decay of Nd^{147}, were studied. The observed correlation functions for the various cascades are as follows:

$$W(_{599}\theta_{91}) = 1 + (0.056 \pm 0.028)P_2(\cos\theta) - (0.049 \mp 0.034)P_4(\cos\theta);$$
$$W(_{442}\theta_{91}) = 1 + (0.065 \pm 0.020)P_2(\cos\theta) - (0.035 \mp 0.025)P_4(\cos\theta);$$
$$W(_{199}\theta_{400}) = 1 - (0.054 \pm 0.020)P_2(\cos\theta) + (0.043 \mp 0.025)P_4(\cos\theta);$$
$$W(_{199}\theta_{491}) = 1 + (0.095 \pm 0.028)P_2(\cos\theta) + (0.014 \mp 0.034)P_4(\cos\theta);$$
$$W(_{120}\theta_{322}) = 1 + (0.035 \pm 0.020)P_2(\cos\theta) - (0.001 \mp 0.025)P_4(\cos\theta).$$

The analysis of the above correlation functions with the ground-state spin of Pm^{147} as $\frac{7}{2}$, and the consideration of the log ft values for the beta transitions from Nd^{147} state of spin $\frac{5}{2}$, give the spin values for the 91, 413, 491, 533, and 690 keV excited states as $\frac{5}{2}$, $\frac{7}{2}$, $\frac{7}{2}$, $\frac{5}{2}$, and $\frac{5}{2}$, respectively. The data of Bishop et al. (1957) and Ambler et al. (1955) on nuclear alignment experiments were reanalysed; the results are consistent with the above spin assignment of $\frac{5}{2}$ for both the 91 and 533 keV levels.

17042 CALCULATION OF l-FORBIDDEN TRANSITION PROBABILITIES. G.M.Bukat.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1716-17 (Dec., 1960).
In Russian.

The reduced matrix element for l-forbidden M1 transitions were calculated by employing a configuration mixture. The results of the calculation are compared with the experimental data. [English translation in: Soviet Physics—JETP (USA), Vol. 12 No. 6, 1198-9 (June, 1961)].

17043 ELECTRIC MONOPOLE TRANSITIONS IN COLLE NUCLEI. A.S.Reiner.

Nuclear Phys. (Internat.), Vol. 27, No. 1, 115-33 (Sept., 1961)

E0 transitions are studied in nuclei with phonon and rotat spectra under the usual assumptions of the Bohr—Mottelson m The rate of E0 transitions in strongly deformed nuclei is sho be proportional to the square of the zero-point fluctuation am tude of the β-vibrations. This quantity can be determined fro experimental data in several independent ways. Where suffic data are available the various values found for this amplitude compared. The agreement found indicates additional proof fo consistency of the model. Expressions for the branching rati of competing E0 and E2 transitions are derived. Because of similarity between the E0 and E2 operators, the branching ra the strong-coupling model is essentially given by the square equilibrium deformation. Contributions to the E2 transition probability due to the rotation—vibration interaction are inclu and found to be appreciable in some cases. Disagreement wit experimental branching ratios is noted and possible reasons discussed.

17044 SUM-COINCIDENCE MEASUREMENTS ON ^{154}Eu.

A.W.Parker.
Austral. J. Phys., Vol. 14, No. 2, 250-9 (June, 1961).

By examining γ-rays from the radioisotope Eu^{154} with a f slow sum-coincidence spectrometer any β-transition to a pos 1.82 MeV level in Gd^{154} was shown to have an abundance less 1% of that of the β-transition to the neighbouring 1.72 MeV le The presence of a 1.60 MeV γ-ray from the 1.72 MeV level is firmed; the intensity of this γ-ray was found to be 6.4% of tha the 1.28 MeV γ-ray.

17045 γ-TRANSITIONS IN THE Sm^{146} NUCLEUS.

É.E.Berlovich, V.N.Klement'ev, L.V.Krasnov and M.K.Nikitin.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 375-7 (Jan., 196
In Russian.

The intensities and the energy spectrum of γ-rays from t decay of Eu^{146} were measured using a double scintillation coi dence spectrometer. The Eu^{146} source was obtained by bomb a target of tantalum with 660 MeV protons and by separating sample of gadolinium from it using chromatographic techniqu From the coincidence study a number of cascade γ-transition Sm^{146} up to an excitation energy of 3.5 MeV were established. [English translation in: Soviet Physics—JETP (USA), Vol. 13 256-7 (July, 1961)]. J.

17046 THE 892.4 keV GAMMA TRANSITION IN W^{182}.

V.D.Vitman, N.A.Voinova, B.S.Dzhelepov and A.A.Karan.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 479-82 (Feb., 1
In Russian.

Results of measurements of the relative intensities of γ- sitions from the 1221.8 keV level in W^{182} to the levels of the g rotational band are presented. The intensity of the 892.4 keV transition is found to be smaller than that computed according the theory for axial nuclei as well as that computed according theory for nonaxial nuclei. [English translation in: Soviet Ph JETP (USA), Vol. 13, No. 2, 335-7 (Aug., 1961)].

17047 SEARCH FOR E0 TRANSITION IN ZINC-68.

M.K.Ramaswamy.
Indian J. Phys., Vol. 34, No. 2, 98-9 (Feb., 1960).

17048 TRANSITION PROBABILITIES FOR ORBITAL ELECTRON CAPTURE AND K/β^+ RATIOS.

P.Depommier, U.Nguyen-Khac and R.Bouchez.
J. Phys. Radium (France), Vol. 21, No. 5, 456-60 (May, 1960)
In French.

Low and Mean Energy Nuclear Physics Colloquium, Gre 1960 (see Abstr. 12029 of 1961). Formulae are obtained for t transition probabilities of K orbital capture and β^+ emission, the case of V A interaction. K/β^+ ratios are calculated for allowed and "unique" transitions, taking into account screeni corrections due to the finite size of the nucleus. The values obtained agree with experiment.

049 THE E.C./β^+ RATIO IN Pr^{130}.
O.Borello, S.Costa and F.Ferrero.
ear Phys. (Internat.), Vol. 27, No. 1, 25-7 (Sept., 1961).
The previously reported (Abstr. 8623 of 1959) value of the
/β^+ ratio for Pr^{130} was re-measured and found to be 4.8.

050 L TO K RATIOS IN THE ELECTRON CAPTURE DECAY OF W^{181} AND Ta^{179}.
Jopson, H.Mark, C.D.Swift and J.H.Zenger.
. Rev. (USA), Vol. 124, No. 1, 157-61 (Oct. 1, 1961).
The L to K ratios were redetermined. Thin (0.060 in.) NaI
als with thin (0.002 in.) Be windows were used to detect the
l K X-rays. The partial fluorescence yields of the L subshells
and Ta were also measured by determining the coincidence
between the L and the K X-rays emitted by the sources. It is
ssary to know the fluorescence yields if the L to K ratios are
determined from the measured intensities of the L and the
rays. The L to K ratio of Ta^{179} was found to be 0.63 ± 0.06,
implies a total decay energy of approximately 115 ± 5 keV
his isotope. This energy is consistent with the observation
o gamma rays accompany the decay of Ta^{179} since the first
ed level of Hf^{179} has an energy (122 keV) exceeding the total
energy of Ta^{179}. The L to K ratio of W^{181} was found to be
± 0.05, from which a decay energy of approximately 260 keV
mputed. This result is in agreement with the fact that two
gamma rays are emitted by the source, one at 137 keV and
ther at 152 keV. These gamma rays correspond to excited
s in Ta^{181}. These gamma rays are in coincidence with the L
ys emitted by the source but not with the K X-rays, which
s that the total decay energy of W^{181} must exceed 166 keV. The
K capture ratios reported here are not in good agreement with
ously reported values.

051 THE DYNAMIC EFFECT OF THE NUCLEAR VOLUME IN CONVERSION M1 TRANSITIONS IN EVEN—EVEN LEI FOR THE NONAXIAL ROTATOR MODEL AND FOR THE ATIONAL MODEL OF THE NUCLEUS. D.P.Grechukhin.
ksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1185-9 (April, 1961).
ssian.
The corrections to the internal conversion coefficient for a
uclear transition arising when the potential produced by the
nuclear electron transition current is taken into account are
ated for the transitions of K, L I, and L II electrons to the
nd $p_{1/2}$ states of the continuous spectrum. The calculations
arried out according to the harmonic vibrational model and
onaxial rotator model (Davydov—Filippov model) of the nucleus.
ish translation in: Soviet Physics—JETP (USA), Vol. 13,
, 832-5 (Oct., 1961)].

052 INTERNAL CONVERSION COEFFICIENTS FOR SOME PURE E2 TRANSITIONS. S.C.Pancholi and N.K.Saha.
. Nat. Inst. Sci. India A, Vol. 26, No. Suppl. 2, 157-64
, 1960).
Internal Conversion Coefficients were examined in a number of
—even types of nucleus for pure E2 transitions ($2^+ \rightarrow 0^+$). A
arison is made between theory and experiment in the light of
's recent (1958) ICC computations for the K-shell and K/L
s. Some previous existing discrepancies were removed.

053 THE K—LL AUGER SPECTRUM OF $_{66}Dy^{161}$.
R.L.Graham and J.S.Merritt.
d. J. Phys., Vol. 39, No. 7, 1058-64 (July, 1961).
The K—LL Auger spectrum of $_{66}Dy^{161}$ was studied using the
k River iron-free β-ray spectrometer at an instrumental
lution of ~ 0.07%. After correcting for the estimated intensity
e L_3 43.81 keV conversion line (96% M1 + 4% E2), which coin-
with the second (K—L_1L_2) Auger line, the following energies
ntensities are obtained for the seven Auger lines:

gy	35.492	35.963	36.369	36.732	36.806	37.195	38.002
	±0.006	±0.007	±0.007	±0.007	±0.010	±0.006	±0.009
ive	1.00	1.31	0.22	0.83	0.28	2.39	1.07
sity	±0.03	±0.05	±0.05	±0.05	±0.03	±0.05	±0.08

energies are from 20 to 50 eV higher than the non-relativistic
ctions. The relative intensities are consistent with experi-
al results at other atomic numbers.

17054 ANGULAR CORRELATION STUDIES OF THE 358 keV → 81 keV CASCADE IN Cs^{133}.
B.N.Subba Rao.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 28-37 (Sept., 1961).
With the main aim of studying the nuclear-structure effect on the internal conversion process of the l-forbidden 81 keV M1 transition, angular correlation measurements with the 358 and 81 keV gamma-rays, and with the 358 keV gamma-ray and the K-conversion electrons of the 81 keV transition were performed. The results, after necessary corrections, are

$$W(\gamma\gamma;\theta) = 1 + (0.046 \pm 0.011)P_2(\cos\theta) - (0.008 \pm 0.014)P_4(\cos\theta),$$
$$W(\gamma e_K{-};\theta) = 1 + (0.014 \pm 0.008)P_2(\cos\theta) + (0.007 \pm 0.011)P_4(\cos\theta).$$

Although gamma—gamma angular correlation alone was not sufficient to choose between $\frac{1}{2}$ or $\frac{3}{2}$ spin assignment to the 439 keV state, the gamma—K-conversion electron angular correlation requires it to be only $\frac{3}{2}$. These angular correlation results lead to a 0.7 M1 + 0.3 E2 multipolarity for the 358 keV transition and $\delta^2_{LL}(\gamma\gamma) = 0.0043$ and $\delta^2_{LL}(\gamma e_K{-}) = 0.0066$ for the 81 keV transition. These different mixing ratios for this transition indicate the possibility of the nuclear structure effect on the internal conversion process being operative. With the help of all these results, the nuclear-structure-effect parameter is deduced from the K-conversion coefficient of the 81 keV transition to be $\lambda = -1.28$ or $+2.53$. The various factors leading to uncertainties in λ are presented. Nuclear-structure effect on particle parameters is considered.

17055 DECAY OF In^{110m}.
W.G.Smith.
Phys. Rev. (USA), Vol. 124, No. 1, 168-72 (Octs. 1, 1961).
The K—L conversion electron energy differences of two transitions with energies equal to 0.1131 and 0.1200 MeV were determined in a permanent magnet spectrograph. These experimental differences (0.02265 MeV) are in agreement only with the K—L_I energy difference of cadmium. Therefore neither of these transitions can follow an isomeric transition in In^{110m}. Energy measurements of two other transitions (0.4614 and 0.5840 MeV) combined with the 0.1200 MeV transition energy measurement show that the 0.1200 and 0.4614 MeV transitions are not in cascade, in parallel with the 0.5840 MeV transition, as proposed by Yoshizawa.

17056 THE DECAY OF Se^{75}.
W.F.Edwards and C.J.Gallagher, Jr.
Nuclear Phys. (Internat.), Vol. 26, No. 4, 649-57 (Sept., 1961).
Using the DuMond bent-crystal gamma-ray spectrometer, the DuMond iron-free ring-focusing beta-ray spectrometer and an iron free low-field semi-circular spectrometer, the energies and relative intensities of the gamma radiations and of the conversion electrons following the decay of Se^{75} into As^{75} were measured. The conversion coefficients and transition multipolarities deduced from this information are given and discussed. Comparisons are made with measurements by other investigators. Inconsistencies between reported values of the mixing parameter of the 279.57 keV M1 + E2 transitions are reconciled and the best value determined is 0.50 ±0.06.

17057 MEASUREMENT OF K-CONVERSION COEFFICIENT OF 279 keV GAMMA RADIATION IN Tl^{203}.
J.P.Hurley and J.M.Ferguson.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 75-8 (Sept., 1961).
The K-conversion coefficient of the 279 keV transition in Tl^{203} was determined by measuring the relative intensities of the 279 keV gamma-ray and the K X-rays from a Hg^{203} source. Using the value $\omega_K = 0.955$ for the fluorescent yield, the conversion coefficient was determined to be $\alpha_K = 0.175 \pm 0.0036$.

17058 GAMMA-RAY DECAY OF THE 7.66 MeV LEVEL OF C^{12}. D.E.Alburger.
Phys. Rev. (USA), Vol. 124, No. 1, 193-8 (Oct. 1, 1961).
Proton—gamma—gamma triple coincidence measurements were carried out on the $B^{10}(He^3,p)C^{12}$ reaction at $E(He^3)$=2·2 MeV. Protons were detected in a $\frac{3}{4}$in. diameter CsI crystal subtending a solid angle of 27% of 4π at the target, the gamma-ray detectors were 5 × 5 in. NaI crystals and the coincidence resolving time was 8×10^{-9} sec. The spectrum of protons in triple coincidence with the two gamma-ray detectors, each channelled from 2.4 to 5.0 MeV, contains a line corresponding to the alpha-emitting 7.66 MeV 0+ second-excited state of C^{12}. This line is interpreted as resulting from the 3.23-4.43 MeV cascade gamma-ray decay of the 7.66 MeV level through the 4.43 MeV 2+ first-excited state.

The ratio of the triples to singles counting rates of the 7.66 MeV proton line, when corrected by the appropriate factors for gamma-ray efficiency, leads to a 3.23 MeV gamma-ray branch of $(3.3 \pm 0.9) \times 10^{-4}$ per decay of the 7.66 MeV level. This branch, which compares with a previous theoretical estimate of $\sim 2 \times 10^{-4}$, is stronger than the direct ground-state transition by a factor of 50.

17059 THE DECAY SCHEME OF Dy^{166}.
L.I.Rusinov, A.V.Borovikov, V.S.Gvozdev, G.D.Porsev, S.L.Sakharov and Yu.L.Khazov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1529-33 (Dec., 1960). In Russian.

Dy^{166} ($T_{1/2}$ = 80.2 hr) was obtained by double neutron capture from Dy^{164} and its decay scheme studied. The multipolarity of the following γ-ray transitions in Ho^{166} were determined: 28 keV (M1), 54.2 keV (E2) and 82.5 keV (M1). Branching ratios for the β decay of Dy^{166} to various levels in Ho^{166} were obtained and a level scheme for low lying states in Ho^{166} is proposed. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1064-7 (June, 1961)].

17060 WEAK GAMMA RAYS IN THE DECAY OF La^{140}.
H.Takekoshi, N.Shikazono and P.Tseng.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1674-7 (Sept., 1961).

Weak gamma-rays of energy 0.63 MeV were found in the decay of La^{140} by means of a scintillation summing Compton spectrometer. These gamma-rays are ascribed to the transition between the 2.53 MeV and 1.90 MeV states of Ce^{140}. The transition between the 1.90 MeV state and the 1.60 MeV state was not detected. The results of the present investigations on the conversion electrons and gamma-rays support the suggestion of Dzelepov et al. that the 1.90 MeV state is a 0^+ one (Abstr. 8547 of 1959).

17061 ANGULAR CORRELATIONS OF GAMMA-GAMMA CASCADES IN Pb^{208}.
L.Simons, M.Brenner, L.Käld, K.E.Nystén and E.Spring.
Comment. phys.-math. (Finland), Vol. 26, No. 6, 35 pp. (1961).

By measuring gamma single and coincidence spectra of the radiation from Th^{228} (RdTh) with scintillation detectors, the commonly accepted level scheme of Pb^{208} was verified within the limits of measurement. The measured relative intensities of the gamma-rays largely agree with previous investigations. Angular correlation measurements yield $\delta = -0.06 \pm 0.05$, δ^2 being the mixing ratio, I(E2)/I(M1), for the 511 keV gamma transition in Pb^{208}. The angular correlation of the 763 keV–(583 keV)–2615 keV cascade in Pb^{208} was determined, and it was confirmed that the 3961 keV level has spin 6- and that the 763 keV gamma-ray is a M1 + E2 mixture with $\delta = -0.45 \pm 0.15$. The angular correlation measurements verify that the levels at 2615, 3198, 3475 and 3709 keV have spins 3^-, 5^-, 4^- and 5^- respectively, that the 2615 and 583 keV transitions are pure E3 and E2 radiations respectively, and that the 860 keV transition is almost pure M1 radiation with $\delta = -0.023 \pm 0.010$.

17062 DOUBLE GAMMA EMISSION IN THE 6.06 MeV MONOPOLE TRANSITION OF O^{16}.
S.Gorodetzky, G.Sutter, R.Armbruster, P.Chevallier, P.Mennrath, F.Scheibling and J.Yoccoz.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 170-2 (Sept. 1, 1961).

A search for the double γ-ray mode of decay of the O^+ 6.03 MeV state in O^{16} was made. The state is formed by the $F^{19}(p,\alpha\gamma)O^{16}$ reaction at the 1880 MeV resonance and α–γ–γ coincidences are observed between a solid state α detector and two NaI crystals. An experimental value of $\Gamma\gamma\gamma/\Gamma\pi = (2.5 \pm 11) \times 10^{-3}$ is obtained.
L.L.Green

17063 THE GAMMA SPECTRUM OF Na^{24} IN THE 2.5–5.5 MeV ENERGY RANGE.
K.P.Artamonova, L.V.Gustova, Yu.N.Podkopaev and O.V.Chubinskiĭ.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1593-5 (Dec., 1960). In Russian.

The hard γ-radiation from Na^{24} was investigated. The previously known γ-lines corresponding to the transitions $h\nu$ = 2.75 and 3.85 MeV were observed, and a more precise determination yielded for the intensity of the latter transition a value $(9 \pm 2) \times 10^{-4}$ quantum per decay. Gamma rays from the transiton $h\nu$ = 4.24 MeV (4230 ± 50 keV), the intensity of which is $(1.5 \pm 0.5) \times 10^{-5}$ quantum per decay, were detected. The upper limit of the intensity of the 5.22 MeV γ-transition, which is possible according to the Na^{24} decay scheme, is estimated at $I_{5.22} \leq 2 \times 10^{-7}$ quantum per decay.

The reduced half-lives for β transitions with E_p = 0.29 and 1.2 are estimated at log ft = 6.6 and log ft = 10.7, respectively. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1109-10 (June, 1961)].

17064 THE LIFETIME OF THE 6.25 keV LEVEL IN Ta^{181}.
M.A.Clark.
Canad. J. Phys., Vol. 39, No. 7, 1090-1 (July, 1961).

The X-ray spectrum from W^{181} was observed in a proporti counter. The spectrum in delayed coincidence, with the tantalu K X-rays observed in a NaI crystal shows a 6.25 keV γ-ray. T lifetime of this state is obtained from delayed coincidence spe and a value of $T_{1/2} = 6.8 \pm 0.4 \times 10^{-6}$ seconds is obtained.
L.L.

NUCLEAR REACTIONS

(Including scattering by nuclei)

17065 THEORY OF NUCLEAR REACTIONS. I. RESONA STATES AND COLLISION MATRIX.
J.Humblet and L.Rosenfeld.
Nuclear Phys. (Internat.), Vol. 26, No. 4, 529-78 (Sept., 1961).

A new formulation of the general theory of nuclear reactio is proposed, on the basis of a definition of the resonant states decaying states corresponding to complex eigenvalues of the t energy of the compound system. A characterization of these states is derived from "natural" boundary conditions expressi the absence of incoming waves in all channels: such boundary conditions yield in a unified form the bound states, the proper resonant states and "virtual" states of a type familiar from th case of the ^1S state of the deuteron. The dispersion formulae elements of the collision matrix determining the reactions cro sections are established, as immediate consequences of their analytical behaviour as functions of the complex energy variab by application of the Mittag–Leffler theorem on the represent of meromorphic functions. The presentation thus obtained, be being simpler than the usual ones, has over the latter the adva of eliminating every arbitrary element from the specification resonances and of the non-resonant background; these element the description are, in particular, independent of the choice of channel radii, and appear altogether as intrinsic properties of compound system.

17066 THEORY OF NUCLEAR REACTIONS. II. THE FOUNDATION OF THE OPTICAL MODEL.
L.Rosenfeld.
Nuclear Phys. (Internat.), Vol. 26, No. 4, 579-93 (Sept., 1961).

An equation determining the optical-model potential in ter of the nuclear interactions is derived from the condition that t model should give the correct shape-elastic scattering, by an argument making direct use of Green's operators, without any expansion in series of orthogonal functions. This method is th fore applicable to the theory in which the resonant states are defined by natural boundary conditions, so that their eigenfunc are not orthogonal. The computation of the collision matrix fo direct interaction processes is performed on the same basis.

17067 NUCLEAR REACTIONS AT MEDIUM ENERGIES.
U.Facchini.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 2, 221-34 (1961). In Italian.

Reviews theories of reactions between nucleons and nucle $A > 20$ in the intermediate energy range (5-20 MeV). Direct interaction, rapid emission and delayed emission are discusse in the light of Kapur–Peierls, compound nucleus and statistic models, and experimental comparisons are made where data i available.
J.W.G

17068 DISPERSION FORMULAE WHICH TAKE INTO AC THE OPTICAL INTERACTION. V.I.Serdobol'skiĭ
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 590-6 (Feb., 196 In Russian.

A formal theory of nuclear reactions is developed which i adequate for treating nuclear problems than the Wigner R-mat theory. The approximate orthogonality between the wave-func of the compound nucleus and the unexcited ground state functio

ed to separate the compound nucleus resonance. The theoretical ment leads to specific dispersion formulae which take into unt the overlapping levels and the interaction between the par- s and the optical potential of the nucleus. [English translation Soviet Physics–JETP (USA), Vol. 13, No. 2, 413-17 (Aug., 1961)].

7069 CALCULABLE MODEL FOR COMPOUND NUCLEUS–DIRECT INTERACTION INTERFERENCE.
Rodberg.
. Rev. (USA), Vol. 124, No. 1, 210-12 (Oct. 1, 1961).
The formation of the compound nucleus is described. The rtance of two-particle excited states is stressed and the ibility of experimentally observing the interference between the ciated "two-particle resonances" and direct-interaction process scussed. Formulae are presented which permit the calculation th the direct-interaction term and the amplitude associated with esonance.

e to Photons

7070 NUCLEAR ELASTIC SCATTERING OF PHOTONS NEAR THE PARTICLE THRESHOLD ENERGY. I.
hei, M.Sugawara, S.Mori and M.Kimura.
ys. Soc. Japan, Vol. 16, No. 9, 1657-63 (Sept., 1961).
The elastic scattering of photons near the particle threshold gy was studied for Al, Si, S, K, Ca, Ni, Cu, Cd, Sn, Pb and Bi. bremsstrahlung X-rays from a 25 MeV betatron were used. pulse of the primary X-rays was expanded up to about 30μsec crease the pile-up effect. The scattered photons were detected scattering angle of 120° with the scintillation spectrometer using I(Tl) crystal and a 30 channel pulse-height analyser gated by xpansion signal of a betatron orbit. The energy at which the s-section has a peak was compared with the particle threshold gy and the value of cross-section was compared with that of cle emission.

7071 INTERFERENCE BETWEEN RAYLEIGH AND NUCLEAR RESONANT SCATTERING OF γ-RAYS.
Moon.
. Roy. Soc. A (GB), Vol. 263, 309-22 (Sept. 19, 1961).
The possibility of observing interference between nuclear nant scattering and Rayleigh scattering of γ-rays is examined reference to (1) thermally broadened medium-energy lines as the 411 keV E2 line of Hg^{198}, (2) recoil-broadened lines bstantial natural width, for example, the 986 keV E1 transition ^{152}, (3) lines of natural width only, as in Fe^{57}. For the first xamples, where the incident spectral distribution is not of le form, a graphical method shows that the interference term nall in comparison with the others whenever the resonant ering is itself a substantial effect, even if full coherence exists een the resonant and Rayleigh components. It remains possible interference may be observable in other examples of the second , to which the graphical method could be extended. For the class, an analytical approach is adopted and leads to the lusion that coherence should be only partial, in the sense that of the resonant scattering reflects the character and preserves hase of the incident radiation, as does the Rayleigh scattering, part is characteristic of the resonator and has no counter- in the Rayleigh scattering. If the incident line is far off nance, these two parts of the resonance radiation will have ictly different frequencies, a single incident line giving a ered doublet. In some circumstances, interference with eigh scattering may aid the observation of a weak resonance st a strong background.

072 THE RESONANT SCATTERING OF GAMMA RAYS IN ^{177}Hf. W.D.Hamilton and B.S.Sood.
ear Phys. (Internat.), Vol. 27, No. 1, 66-74 (Sept., 1961).
Matched hafnium oxide and tantalum carbide scatterers were to determine the intensities of resonant and fluorescent tered γ-rays from the 113 keV and 321 keV levels in Hf^{177}; source of radiation was Lu^{177} in the form of lutetium oxide. resonant scattering condition was provided by the thermal dening of the level widths, and the resonant fluorescent cross- ions were found relative to the known Rayleigh scattering s-sections. The partial mean-lives for the γ-transitions have values τ (113 keV; E2) = 1.5 ± 0.5 nsec and τ (321 keV; E1) = ±5 nsec. When compared to the single-particle estimates, these results indicate an enhancement factor of almost 330 for the 113 keV transtion, but a hindering of 321 keV transition by a factor greater than 10^6. The results, in general, are consistent with previous investigations and may be interpreted on the basis of the Nilsson model.

17073 ANGULAR DISTRIBUTION OF FAST PHOTONEUTRONS.
R.G.Baker and K.G.McNeill.
Canad. J. Phys., Vol. 39, No. 8, 1158-71 (Aug., 1961).
The angular distributions and the yields of the high-energy neutrons emitted in photodisintegration were studied by silicon detectors (25 elements) and aluminium detectors (6 elements). With the silicon detectors systematic variations are apparent in the coefficient a_2 of $W(\theta) = a_0(P_0 + a_2P_2)$, and these variations are interpreted in terms of the Wilkinson shell model of photonuclear reactions.

17074 RECENT RESULTS ON THE NUCLEAR PHOTOEFFECT.
R.Malvano.
Nuovo Cimento Suppl. (Italy), Vol. 12, No. 2, 152-71 (1961).
In Italian.
A review of the present state of the photonuclear effect. Some aspects of the effect in the region of the giant resonance and above are considered and several new experimental techniques discussed.
S.J.St-Lorant

17075 RECENT RESULTS ON PHOTONUCLEAR SPECTRA.
C.Milone.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 2, 172-93 (1961).
In Italian.
A summary of experimental work on the nuclear photoeffect in the region of the giant resonance. S.J.St-Lorant

17076 THE MECHANISM OF PHOTONUCLEAR REACTIONS.
A.M.Badalyan and A.I.Baz'.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 549-52 (Feb., 1961).
In Russian.
A number of empirical laws cannot by explained by the statistical mechanism of photonuclear reactions if the energy of the gamma quantum is less than or equal to 10 MeV. The facts can be explained only by assuming that a few single-particle states of the target nuclei contribute significantly to the cross-section of the photonuclear reaction. The nature of these states is discussed. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 383-6 (Aug., 1961)].

17077 NEUTRON POLARIZATION IN THE DISINTEGRATION OF Be^9 NUCLEI BY CIRCULARLY POLARIZED GAMMA QUANTA. I.Sh.Vashakidze, T.I.Kopaleishvili and G.A.Chilashvili.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 491-2 (Feb., 1961).
In Russian.
The polarization of photoneutrons emitted in the reaction $Be^9(\gamma,n)Be^8$ is determined for circularly polarized γ-quanta. It is shown that for certain neutron emission angles the polarization is as high as ~ 50%. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 343-44 (Aug., 1961)].

17078 NUCLEON CORRELATIONS AND PHOTONUCLEAR REACTIONS. II. (γ,p) AND (γ,n) REACTIONS IN THE NONRESONANCE REGION ($E\gamma \geq 30$ MeV). G.M.Shklyarevskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8) 451-5 (Aug., 1961).
In Russian.
It is shown that it is important to take into account nucleon pair correlations for explanation of the cross-sections of single nucleon photonuclear reactions (e.g. the reactions (γ,p) and (γ,n), at energies exceeding the giant resonance. [English translation in: Soviet Physics–JETP (USA)].

17079 NUCLEAR ABSORPTION OF PHOTONS BY C^{12} AND AL^{27}.
G.Tamas, J.Miller, C.Schuhl and C.Tzara.
J. Phys. Radium (France), Vol. 21, No. 5, 299 (May, 1960).
In French.
Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). See following abstract.

17080 NUCLEAR ABSORPTION OF PHOTONS BY C^{12} AND Al^{27}. G.Tamas, J.Miller, C.G.Schuhl and C.Tzara.
J. Phys. Radium (France), Vol. 21, No. 6, 532-6 (June, 1960).
In French.
A Compton spectrometer was used for measuring by trans-

mission the total nuclear absorption cross-section of C^{12} and Al^{27}. The results are compared with the predictions of various sum rules. Some interesting facts appear from this, but it is necessary to increase the precision of the measurements.

17081 EFFECTIVE CROSS-SECTION OF THE REACTION $C^{12}(\gamma,3\alpha)$ AT 14.8 AND 17.6 MeV.
M.Garnier, H.Gauvin and W.Sebaoun.
J. Phys. Radium (France), Vol. 21, No. 12, 893-5 (Dec., 1960).
In French.

The effective cross-section of the reaction $C^{12}(\gamma,3\alpha)$ was determined by a comparison with the effective cross-section of the reaction $Cu^{63}(\gamma,n)Cu^{62}$. The results at 14.8 and 17.6 MeV were $(0.44 \pm 0.11)\ 10^{-28}$ cm^2 and $(1.90 \pm 0.21)\ 10^{-28}$ cm^2, respectively.
B.Brown

17082 FINE STRUCTURES OF PHOTOPROTONS FROM Si^{28}.
K.Shoda, K.Kobayashi, S.Siina, K.Abe and M.Kimura.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1031-2 (May, 1961).

The 9.38 mg cm^{-2} Si target was bombarded with 24 MeV bremsstrahlung, and the protons were detected in nuclear emulsion. The spectrum obtained agrees with the statistical model, apart from its fine structure. It is compared with that predicted from the inverse reaction.
A.Ashmore

17083 AN INVESTIGATION OF THE $Sn^{120}(\gamma,p)$ REACTION.
Go Tsi-di [Kuo Ch'i-Ti] and B.S.Ratner.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1578-84 (Dec., 1960).
In Russian.

The cross-sections for the reactions $Sn^{120}(\gamma,p)In^{119}$ and $Sn^{120}(\gamma,pn)In^{118}$ were measured by recording the induced radioactivity. The maximum of the (γ,p) cross-section, at $E_{\gamma\,max} = 20.8 \pm 0.5$ MeV, is 6.5 ± 0.6 mb. The integral cross-sections are 28 ± 3 and 5.0 ± 1 mb-MeV for the (γ,p) and (γ,pn) reactions, respectively. A new half-life $T = 2.1 \pm 0.2$ min was detected which corresponds to the ground state in the presented decay scheme of In^{119}. The results are discussed on the basis of the Wilkinson model (Abstr. 1973 of 1958). [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1098-1102 (June, 1961)].

17084 RATIO OF CROSS-SECTIONS FOR PRODUCTION OF NEGATIVE AND POSITIVE PHOTO-MESONS IN BERYLLIUM.
M.I.Adamovich, N.M.Panova, V.M.Popova and F.R.Yagudina.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1585-8 (Dec., 1960).
In Russian.

The ratio of the yields of the charged mesons emitted at 90° to a photon beam irradiating a beryllium target was measured. The spectrum of the photons was of bremsstrahlung with maximum energy 250 MeV. The energy spectra of the mesons were obtained in the energy range 12 to 40 MeV. The ratio of the cross-sections for photo production of π^- and π^+ mesons is $\sigma^-/\sigma^+ = 1.8 \pm 0.15$. These results are discussed. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1103-5 (June, 1961)].

Due to Electrons

17085 INELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS BY NUCLEI. A.G.Sitenko and V.N.Gur'ev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1760-5 (Dec., 1960).
In Russian.

The inelastic scattering of fast electrons by nuclei is treated for cases in which the scattering is accompanied by the ejection of nucleons from the nucleus. The differential cross-section for the process is expressed in terms of the correlation function for the nucleons that is caused by two-particle interactions. The correlation function obtained from an analysis of the data on the capture of neutrons by protons colliding with nuclei is used to calculate an energy spectrum of the electrons, which agrees with the experimental data. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1228-31 (June, 1961)].

17086 THE ELASTIC SCATTERING OF 426 MeV ELECTRONS BY LITHIUM-6. N.J.Patel and C.M.Bhavsar.
Current Sci. (India), Vol. 30, No. 2, 51-2 (Feb., 1961).

This is calculated using two different general forms for the density distribution which have been proposed for light nuclei; agreement with experiment is poor. A simple Gaussian distribu is found which gives good agreement with the Li^6 data.
E.J.Squ

17087 BREMSSTRAHLUNG OF SLOW ELECTRONS DECELERATED BY NEUTRAL ATOMS.
O.B.Firsov and M.I.Chibisov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1770-6 (Dec., 196
In Russian.

The bremsstrahlung cross-section for slow ($E_{el} < 3$ eV) electrons colliding with neutral atoms is expressed in terms of cross-section for elastic scattering of electrons on atoms. The absorption coefficient of the radiation is determined. The range gas temperatures and pressures in which collisions between the electrons and atoms yield the largest contribution to the radiati indicated. [English translation in: Soviet Physics—JETP (USA) Vol. 12, No. 6, 1235-9 (June, 1961)].

17088 MEASUREMENT OF ELECTRON SCATTERING IN CARBON TO COMPARE WITH A MUON EXPERIME
G.E.Masek, J.P.Toutonghi, R.W.Williams and D.H.Coward.
Phys. Rev. (USA), Vol. 124, No. 2, 555-60 (Oct. 15, 1961).

The inelastic scattering of high-energy electrons in carbon measured so as to provide an experimental cross-section to compare with a recent measurement of muon scattering (Abstr. of 1961). A scaling law which connects the electron result with (higher-energy) muon result is described. Results for the sum (elastic plus all inelastic) cross-section at two values of the mu scattering angle are presented. At the smaller angle (momentu transfer ~200 MeV/c) agreement with the theoretical Drell—Sch sum rule (Abstr. 3910 of 1959) is good; at the larger one (~280 MeV/c) it is poorer but within the experimental and theor al uncertainties. Comparison with the muon results does not al the previous conclusion: that no muon scattering anomaly is se

Due to Nucleons

17089 ON THE OPTICAL MODEL FOR THE NUCLEON–NUCLEUS SCATTERING.
J.Dąbrowski and A.Sobiczewski.
Acta phys. Polon. (Poland), Vol. 20, No. 3, 243-55 (1961).

The real and imaginary parts of the medium- and high-ener potential for nucleon—nucleus scattering were calculated for an infinite nuclear medium with the help of the recent phenomenolo gical nucleon—nucleon phase shifts. For the S-wave contributio the exact solution of the equation for the nucleon—nucleon scatt for the separable nucleon—nucleon interaction was used. In calculation of the $l>0$ contribution to the imaginary part of the optical potential the Goldberger method (Abstr. 1178 of 1949) wa applied. The results are compared with experiment and discus

17090 NUCLEON—NUCLEUS SCATTERING AND THE CHO BETWEEN SETS OF NUCLEON—NUCLEON PHASE SHIFTS. A.M.Saperstein.
Progr. theor. Phys. (Japan), Vol. 25, No. 4, 716-17 (April, 1961

It is shown that multiple scattering effects can be expected obscure the differences between nucleon—nucleus elastic scatte polarizations calculated with different sets of nucleon—nucleon phase shifts and hence make choices bases upon the Born appro ation unreliable (Abstr. 10885 of 1961).
C.W

17091 ABSORPTION CROSS-SECTIONS FOR THE NUCLEA SCATTERING OF HIGH ENERGY NUCLEONS.
G.Z.Shah and B.M.Thaker.
Current Sci. (India), Vol. 30, No. 6, 215-16 (June, 1961).

Experimental data on absorption cross-sections for nucleon on complex nuclei in the energy range 140 MeV to 4.0 BeV toget with values of the free pp and pn total cross-sections in the sam energy range are used to demonstrate the existence of a charac istic nuclear transparency curve.
J.D.Do

ANGULAR DISTRIBUTION OF SHOWER PARTICLES IN NUCLEAR INTERACTIONS OF FAST NUCLEONS WITH HEAVY EMULSION NUCLEI. See Abstr. 16936

e to Protons

092 ELASTIC SCATTERING OF 8 MeV POLARIZED PROTONS.
sen, J.E.Brolley, Jr, M.L.Gursky and L.Stewart.
. Rev. (USA), Vol. 124, No. 1, 199-202 (Oct. 1, 1961).
The angular dependence of the polarization produced in the ic scattering of 8 MeV protons by complex nuclei was sured for 23 elements. The polarization exhibits a smooth ndence on mass number and scattering angle for most of the ents studied. The systematics in the angular distributions reproduced by an optical model calculation in which only the is is permitted to vary. (For previous work at 10 MeV, see r. 3440 of 1961).

7093 CALCULATION OF THE ELASTIC SCATTERING CROSS-SECTIONS FOR 5.45 MeV PROTONS ORDING TO THE OPTICAL MODEL OF THE NUCLEUS.
Vanetsian, A.P.Klyucharev, G.F.Timoshevskii and Fedchenko.
eksper. teor. Fiz.(USSR), Vol. 40, No. 4, 1199-202(April, 1961).
ıssian.
The differential cross-sections for the elastic scattering of MeV protons from the separated isotopes $Cr^{52,53}$, Co^{59}, ^{60,62,64}, $Zn^{64,68}$ and Cu^{65} were calculated with the help of the plex optical model potential. The real part of the potential chosen in the Saxon form and the imaginary part in the sian form. Satisfactory agreement with the experimental was achieved for isotopes whose (p,n) threshold is below the gy of the scattered protons. It was impossible to make the al model calculations consistent with the experimental data for pes whose cross-sections increase at large angles. [English slation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 842-4 , 1961)].

7094 ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED 14 MeV NEUTRONS.
Strizhak, V.V.Bobyr' and L.Ya.Grona.
eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 313-16 (Aug., 1961).
ıssian.
The differential cross-sections for scattering of 14 MeV neut- on carbon, nitrogen, sulphur (angular range 20-140°), molyb- m, cadmium and tellurium (angular range 15-160°) were meas- . After the introduction of the necessary corrections, the ex- mental data are compared with the cross-sections computed rding to the optical model of the nucleus. [English translation Soviet Physics—JETP (USA)].

7095 THE ELASTIC AND INELASTIC SCATTERING OF PROTONS BY MAGNESIUM IN THE ENERGY RANGE M 7.3 MeV TO 15.9 MeV.
atsuda, Y.Nagahara, Y.Oda, N.Yamamuro and S.Kobayashi.
ear Phys. (Internat.), Vol. 27, No. 1, 1-24 (Sept., 1961).
Twenty-seven proton angular distributions for the elastic ering from magnesium and for the inelastic scattering from , leading to the first excited state at 1.37 MeV, are presented e energy range from 7.32 MeV to 15.85 MeV. The elastic lar distribution shows generally maxima and minima of the action type. The absolute cross-sections at fixed angles, how- , vary appreciably from energy to energy, particularly at back- angles. The angular distribution for inelastic scattering varies rkably with the incident energy, especially in the energy range than 12 MeV. The integrated cross-section for the inelastic ering also shows variations with energy. The results are pared with those which have been obtained in other laboratories vith those for other target nuclei obtained in the authors' ratory. The emitted spectrum of inelastic protons is also ented in connection with the study of angular distribution. The lusion is that neither the simple theory of direct process and/or al model, nor that of compound process explains the results pletely.

7096 SPIN AND PARITY ASSIGNMENTS TO THE E_p = 504 keV AND E_p = 506 keV RESONANCE LEVELS $Al(p,\gamma)^{28}Si$. P.B.Smith and J.Kuperus.
ica (Netherlands), Vol. 26, No. 8, 631-2 (Aug., 1960).
Measurements performed with the Utrecht 850 keV cascade rator yield values of 2^+ and 1^+ for the spin and parities of the 504 and 506 keV resonance levels, provided the angular momentum mixing of the captured protons is left out of consideration.
G.Martelli

± 17097 GAMMA RAYS FROM THE ^{27}Al (p,γ) REACTION.
S.Bashkin and T.R.Ophel.
Austral. J. Phys., Vol. 14, No. 3, 335-46 (Sept., 1961).
Gamma-ray spectra and angular distributions were measured at the 759, 766, 773, and 993 keV resonances of the $Al^{27}(p,\gamma)$ reaction. The results obtained at the lower resonance are in agreement with previous work. At the 993 keV resonance, a transition to the 7·80 MeV level of Si^{28} was observed. Tentative J^π assignments to the resonance levels of 2-(759 keV), 4-(766 keV), 1^+(773 keV), and 3^+(993 keV) are discussed.

17098 CROSS SECTIONS OF (p,pxn) REACTIONS IN Au^{197}.
T.M.Kavanagh and R.E.Bell.
Canad. J. Phys., Vol. 39, No. 8, 1172-83 (Aug., 1961).
Cross-sections of (p,pn), (p,p2n), and (p,p3n) reactions in Au^{197} were measured by the activation method for incident proton energies up to 86 MeV. The curves of cross-section as a function of energy have similar shapes for the three reactions. They rise from apparent thresholds at about 16, 21, and 30 MeV, respectively, to peak values of 180, 145, and 150 mb at proton energies about 30 MeV higher than the apparent threshold energies. The cross-sections are much larger than those predicted from the statistical and cascade-evaporation theories, and they are interpreted in terms of two-body collisions in the diffuse surface of the target nucleus. A combination of these results with measured (p,xn) cross-sections yields an approximation to the total reaction cross-section of a heavy nucleus.

17099 THE SPIN AND PARITY OF THE 648 keV RESONANCE IN $Mg^{26}(p,\gamma)Al^{27}$. R.Nordhagen.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 112-14 (Sept., 1961).
The spin and parity of the 648 keV resonance in $Mg^{26}(p,\gamma)Al^{27}$ are discussed and tentatively assumed to be $\frac{5}{2}^-$.

17100 O^{16} (ρ, α) N^{13} ANGULAR DISTRIBUTIONS AT 13.5-18.1 MeV. D.R.Maxson.
Phys. Rev. (USA), Vol. 123, No. 4, 1304-9 (Aug. 15, 1961).
Angular distributions of alpha particles from the O^{16}(p, α) N^{13} ground-state reaction were measured with an ionization chamber at 10 bombarding energies from 13.5 to 18.1 MeV. The angular distributions are oscillatory but not of the form predicted by the plane wave pickup or knockon theories, and the variation with energy is more pronounced than would be expected for a simple direct reaction. The excitation curve has a minimum at $E_p \cong 16.5$ MeV, and the angular distributions are markedly different above and below that energy. The $O^{16}(p,\alpha)N^{13*}$ (2.4 MeV) reaction is also strongly energy dependent, and the O^{16} (p,p)O^{16} elastic scattering cross-section is quite energy-sensitive at large angles. The energy dependence of the scattering cross-section at 125° appears to be correlated with the O^{16} (p, α) N^{13} excitation function.

17101 INTERACTION OF HIGH ENERGY PROTONS FROM THE CERN PROTON SYNCHROTRON WITH PHOTOGRAPHIC EMULSION NUCLEI.
C.Bricman, M.Csejthey-Barth, J.P.Lagnaux and J.Sacton.
Nuovo Cimento (Italy), Vol. 20, No. 5, 1017-21 (June 1, 1961).
Results are reported for the interactions produced in a nuclear emulsion by protons in a rather wide momentum range around 15 GeV/c. 504 interactions, giving a mean free path of 28.8 ± 1.3 cm, are classified according to the number of shower particles ($\beta > 0.63$) and heavy particles ($\beta < 0.63$). When combined with other results, the trend in the multiplicity with energy is obtained. A.Ashmore

17102 EXPERIMENTAL RESULTS ON THE PROTON—NUCLEUS COLLISIONS AT 27 GeV IN EMULSION.
A.Barbaro-Galtieri, A.Manfredini, B.Quassiati, C.Castagnoli, A.Gainotti and I.Ortalli.
Nuovo Cimento (Italy), Vol. 21, No. 3, 469-83 (Aug. 1, 1961).
The characteristics of 3226 stars produced by collisions of 27 GeV protons against nuclei in emulsions are examined. The mean multiplicities $n_s = 6.6 \pm 0.1$, $n_h = 7.2 \pm 0.2$ are obtained. The mean energy of the secondary shower particles is 2.3 ± 0.2 GeV. The energy transfer to the secondary mesons in the l.s. is $K \sim 0.6$. From the study of the angular distribution the mean number of

collisions inside the nucleus is found to be 1.1 and 2.7 for light and heavy nuclei respectively. The mean free path for absorption is $\lambda = 38.0 \pm 1.0$ which according to an optical model corresponds to a nuclear mean free path $\lambda_n = (4.3 \pm 0.3)$ fermi.

17103 SECONDARY PROCESSES ON THE PRODUCTION OF PIONS IN NUCLEI. V.M.Mal'tsev and Yu.D.Prokoshkin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1625-9 (Dec., 1960). In Russian.

The production of π mesons in p–C collisions at an energy of 660 MeV is calculated by the Monte Carlo method. It is shown that the scattering of π mesons changes appreciably the π-meson angular distributions and the ratio of the positive and negative π-meson yields. The angular dependence obtained for this ratio agrees with the experimental data. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1134-7 (June, 1961)].

17104 ON THE MECHANISM OF INTERACTION OF FAST PROTONS WITH NUCLEI. K.D.Tolstov.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 144-7 (Sept., 1961).

Discusses the results on the interaction of 9 GeV protons with emulsion nuclei. The comparison drawn using the data on nucleon–nucleon collisions warrants the conclusion that the cascade mechanism of interaction with nuclei is valid.

17105 CROSS-SECTION FOR THE DECAY OF C^{12} INTO 3 α-PARTICLES WHEN PRODUCED BY 90 MeV PROTONS AND PROBABILITY OF A TRANSITORY α-PARTICLE STRUCTURE. H.Gauvin, R.Chastel and L.Vigneron.
C.R.Acad. Sci. (France), Vol. 253, No. 2, 257-9 (July 10, 1961). In French.

The events were recognized in loaded nuclear emulsion and subjected to kinematical conditions for identification. 61 events were thus identified. After corrections had been applied the cross-section obtained was 5.4 ± 0.9 mb. Assuming the 8 events with an α-particle of energy > 30 MeV to be due to a collision with an α-particle in the nucleus, the probability thereof is about 0.30.
A.Ashmore

17106 THE INTERACTION OF 660-MeV PROTONS WITH CARBON, NITROGEN, AND OXYGEN NUCLEI.
N.A.Perfilov and Yu.I.Serebrennikov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 400-8 (Feb., 1961). In Russian.

Sandwich emulsions (a 2μ gelatin layer between two 100 μ emulsion layers) were used to record 1044 disintegrations of C, N, and O nuclei induced by 660 MeV protons. Analysis of the disintegrations indicates that the process involves a two-stage mechanism. The excitation energy, mean charge $\bar{Z}$, and mean mass $\bar{A}$, are estimated for the residual nucleus, which is formed after the cascade stage of the disintegration. The angular distributions of the charged particles are obtained. The mean lifetime of α-particle substructures inside light nuclei is estimated. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 274-9 (Aug., 1961)].

Due to Neutrons

17107 TIME-DEPENDENT NEUTRON SPECTRA. J.Koppel.
Nuclear Sci. Engng (USA), Vol. 8, No. 2, 157-63 (Aug., 1960).

The time-dependent slowing down of neutrons against free nuclei at rest is studied in the space independent case. New approximate and exact solutions for constant scattering and 1/v or constant absorption cross-section are obtained and compared with previously reported work.

17108 THE ABSOLUTE MEASUREMENT WITH A COINCIDENCE TELESCOPE OF THE EFFECTIVE CROSS-SECTIONS OF (n, p) AND (n, d) REACTIONS.
P.Lévy and Bonnel.
J. Phys. Radium (France), Vol. 22, No. 8-9, 489-99 (Aug.-Sept., 1961). In French.

In order to study selectively (n,p) and (n,d) reactions for various elements, an arrangement was built with a coincidence telescope allowing differentiation of particles by observation of the coordinates of a spot on an oscilloscope. Together with absolute measurements of neutron flux, this installation enables total and differential reaction cross-sections to be determined. The reactions F^{19} (n,d) O^{18} and deuteron breakup reactions are as illustrative examples, and results are compared with earlier results.

17109 ON SLOW AND RAPID NEUTRON-CAPTURE PROCESSES IN THE THEORY OF ORIGIN OF THE ELEMENTS. G.S.Malkiél.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1637-40 (Dec., 19
In Russian.

A hypothesis concerning the synthesis of the elements with $Z > 30$ by means of neutron capture is discussed. It is shown t the time required for the synthesis of stable nuclei is of the or of 100 days. Arguments are presented which indicate that neut numbers 98, 108, and 116 may be favoured. [English translati in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1143-5 (June,

17110 THERMAL NEUTRON CAPTURE γ-RAYS. L.V.Groshev, B.I.Gavrilov and A.M.Demidov.
Atomnaya Energiya (USSR), Vol. 6, 281 (1959). In Russian. En translation in: Reactor Sci. (GB), Vol. 12, No. 1-2, 47-54 (May, 1960).

A magnetic Compton spectrometer was used to study the spectra of γ-rays from a number of (n,γ) reactions induced by thermal neutrons from the USSR Academy of Sciences VVR rea A description of the experimental conditions is given, and the r obtained for the γ-ray spectra from Sn and Sb are presented.

17111 INTERFERENCE IN THE RADIATIVE CAPTURE O NEUTRONS. R.E.Coté and L.M.Bollinger.
Phys. Rev. Letters (USA), Vol. 6, No. 12, 695-7 (June 15, 1961)

The relative intensity of individual capture γ-rays as a fur of neutron energy in the vicinity of the Pt^{195} resonances at 11.9 19.6 eV was measured. By fitting theoretical curves to the exp mental data it is concluded that interference occurs between radia transitions associated with neutron resonances of the same J a that it is dominated by the two measured levels. F.E

17112 SPECTROSCOPY AT INTERMEDIATE NEUTRON ENERGY, USING A TIME OF FLIGHT METHOD WI HIGH RESOLUTION.
C.Corge, V.-D.Huynh, J.Julien, J.Morgenstern and F.Netter.
C.R. Acad. Sci. (France), Vol. 253, No. 5, 859-61 (July 31, 196 In French.

Resonances in the transmission curve for U^{235} were obtain with neutron energies between 1 and 3.5 keV, at a minimum resolution of 1 mμsec m^{-1}. The distribution of level densities agrees well with theory. The majority of resonances observed As, Zn and Pr, using 2.5 mμsec m^{-1} resolution, were previous undetected. V.M

17113 SOME NEW ACTIVITIES PRODUCED BY FAST NEUTRON BOMBARDMENTS.
K.Takahashi, T.Kuroyanagi, H.Yuta, K.Kotajima, K.Nagatani a H.Morinaga.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1664-74 (Sept., 1961).

Several new nuclides were produced in the internal target the INS cyclotron from the fast neutron bombardments of Ge, M Gd, Er, Yb and Hf. Their radiation characteristics were deter mined with the aid of beta- and gamma-ray scintillation spectr meters. The new activities observed are as follows:

Nuclides	Half-lives	Beta rays	Gamma rays
Ga^{76}	32 ± 3 sec	~6.0 MeV	0.57, 0.96, 1.12 M
Nb^{98}	51 ± 5 min	3.5 ± 0.1 MeV others	0.78 MeV, many ot
Nb^{100}	11.5 ± 1.0 min	4.2 ± 0.1 MeV others	0.53 MeV, many ot
Eu^{160}	~2.5 min	3.6 ± 0.5 MeV	none
Ho^{168}	~3.5 min	~2.2 MeV	0.85 MeV
Ho^{170}	45 ± 5 sec	~3.1 MeV	0.43 MeV
Tm^{174}	~5.0 min	2.5 ± 0.1 MeV	none
Tm^{176}	1.5 ± 0.3 min	4.2 ± 0.1 MeV	none
Lu^{180}	2.5 ± 0.5 min	3.3 ± 0.1 MeV	none

The radiation characteristics were analysed in the light of the unified model and the conventional nuclear level systematics.

17114 GAMMA RADIATION FROM INELASTIC SCATTER OF 14 MeV NEUTRONS BY THE COMMON EARTH ELEMENTS. R.L.Caldwell, W.R.Mills, Jr and J.B.Hickman, Jr
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 173-82 (Sept., 1960).

Gamma rays in the energy range 2-11 MeV produced by

tic scattering of 14 MeV neutrons by nine elements were red at a mean angle of 90°. Excluding carbon and oxygen, aximum energy gamma rays varied from about 8 MeV for norus to about 10.5 MeV for magnesium and 11 MeV for silicon. ved gamma rays were observed from carbon (4.43 MeV), n (6.1 and 7 MeV), silicon (1.78 MeV), aluminium (2.2 MeV), norus (2.2 MeV), sulphur (2.2 MeV), and calcium (3.7 MeV). energy range 4-6 MeV there are indications of individual a rays in silicon; no resolved gamma-ray peaks above 2 MeV bserved for iron and magnesium. Except for carbon and n, the intensity of gamma rays decreases with increase in and varies from about 3 to 9 times higher at 2-3 MeV than MeV. Gamma-ray production cross-sections are given for lement, relative to the known cross-section for carbon. The f the integrated cross-section for gamma-ray production 2 MeV to the nonelastic cross-section varies from 0.59 for r to 0.99 for iron.

115 REACTOR NEUTRON ACTIVATION CROSS-SECTIONS FOR A NUMBER OF ELEMENTS. W.S.Lyon.
r Sci. Engng (USA), Vol. 8, No. 5, 378-80 (Nov., 1960).
irty experimentally determined reactor neutron activation -sections found by use of the ORNL Graphite Reactor are The general method of measurement is described.

116 CROSS SECTIONS OF VARIOUS MATERIALS IN THE [LOS ALAMOS] GODIVA AND JEZEBEL CRITICAL MBLIES. C.C.Byers.
r Sci. Engng (USA), Vol. 8, No. 6, 608-14 (Dec., 1960).
eutron activation (n, γ) cross-sections of twenty-five isotopes letermined by a comparison activation method. Where these represent total capture, they may be used in conjunction with ve absorption cross-sections (σ_a) from reactivity contribution rements to obtain the effect of energy degradation of the ns by inelastic scattering.

117 CROSS-SECTIONS FOR RADIATIVE CAPTURE OF NEUTRONS BY HEAVY NUCLEI. P.É.Nemirovskiĭ.
sper. teor. Fiz. (USSR), Vol. 39, No. 6, 1737-43 (Dec., 1960).
sian.
is shown that even at low energies (beginning at 1 keV) e neutrons are important in radiative capture by heavy nuclei. rgies of 0.1–1.0 MeV, neutrons with $l = 1, 2, 3$, dominate the e cross-section. The optical model gives satisfactory ment with the experiments. In the absence of inelastic ring the radiative capture cross-section becomes constant at es greater than 0.3 MeV; it increases somewhat at higher es, owing to the increasing level density. If there is inelastic ring of neutrons with low l-values, the cross-section is proportional to E^{-1}. [English translation in: Soviet Physics–(USA), Vol. 12, No. 6, 1213-16 (June, 1961)].

118 INTERACTION OF 14.1 MeV NEUTRONS WITH Be^9. S.A.Myachkova and V.P.Perelygin.
sper. teor. Fiz. (USSR), Vol. 40, No. 5, 1244-9 (May, 1961).
sian.
he interaction was investigated using photographic emulsions. nergy and angular distributions of neutrons and α particles ced in the (n,2n) and (n,α) reactions were measured. The data ed indicate that the reaction essentially involves a 2.9 MeV d state in the Be^8 nucleus (cross-section 0.19 ± 0.06 bn) and MeV excited level in the Be^9 level. The cross-section for tion of the Be^9 (2.43 MeV) nucleus and for formation of the d state in the Be^9 nucleus is 0.2 ± 0.1 bn. Direct interactions ield an appreciable contribution to the (n,2n) reaction. The ross-section for the reaction is 0.54 ± 0.07 bn. [English ation in: Soviet Physics–JETP (USA)].

CAPTURE-GAMMA-RAY SPECTRUM OF Cd^{113} $(n,\gamma)Cd^{114}$ AND THE ASSOCIATED ENERGY LEVELS R.K.Smither.
Rev., (USA), Vol. 124, No. 1, 183-92 (Oct. 1, 1961).
he capture gamma-ray spectrum of $Cd^{113}(n,\gamma)Cd^{114}$ was igated with the Argonne 7.7 m bent-crystal spectrometer. bserved spectrum consisted of 119 gamma rays with energies 2 MeV. These precision energy measurements were combined series of coincidence experiments to modify and extend the scheme of Cd^{114}. The errors in the energy values of five ously observed levels are reduced by a factor of 10. Their alues are found to be 557.8 ± 0.1, 1208.4 ± 0.2, 1282.2 ± 0.2, 1304.9 ± 0.3, and 1362.9 ± 0.3 keV. Five new levels are established at 1133.1 ± 0.2, 1730.3 ± 02, 1839.9 ± 0.3, 1958.3 ± 0.3, and 2202.4 ± 0.3 keV. Eight more levels are suggested at 1607.8 ± 0.3, 2048.3 ± 0.4, 2225.1 ± 0.4, 2392.5 ± 0.4, 2573.8 ± 0.5, 2868.0 ± 0.7, 3216.8 ± 0.8, and 3484.7 ± 0.8 keV. The limits placed on the spins and parities of these levels by the observed capture gamma rays are discussed.

17120 CASCADE γ-TRANSITIONS IN Cl^{36} ACCOMPANYING THERMAL NEUTRON CAPTURE. V.R.Burmistrov.
Atomnaya Energiya (USSR), Vol. 7, 260 (1959). In Russian.
English translation in: Reactor Sci. Technol. (GB), Vol. 12, No.3, 133-5, (June, 1960).
The γ-radiation resulting from thermal neutron capture in chlorine has been studied, using the beam from the first atomic power station reactor. Considerable details are given of the equipment and the experimental technique. The measurements led to the conclusions that cascades of 7.79 - 0.79 MeV, 7.42 - 1.16 MeV, 5.72 - 2.88 Mev, and 6.11 - 0.51 - 0.79 - 1.16 MeV exist.
B.Brown

17121 DOUBLE CASCADE TRANSITIONS OF GAMMA RAYS FROM RADIATIVE CAPTURE ON Co^{59}.
J.Urbanec, J.Kajfosz and J.Kopecký.
Czech. J. Phys., Vol. 11, No. 8, 559-64 (1961).
Pairs of gamma quanta, with a total energy equal to the binding energy of the last neutron in a Co^{60} isotope, were studied during radiative capture of neutrons by a Co^{59} nucleus. The energies of the gamma quanta producing such cascades were determined and an attempt was made to determine the relative intensities of the different cascades.

17122 THE THERMAL NEUTRON CROSS-SECTION OF THE REACTION $^{137}Cs(n,\gamma)^{138}Cs$. D.C.Stupegia.
Reactor. Sci. (GB), Vol. 12, No. 1-2, 16-25 (May, 1960).
The cross-section was found to be 0.110 ± 0.033 barns in a flux having a resonance flux, ϕ_r/ϕ_{th}, equal to 0.00277, where ϕ_r/ϕ_{th} is the resonance flux per unit interval of ln E, per unit thermal flux, and the resonance neutron energy ranges from 0.4 eV up to the energy of fission neutrons.

17123 LOW-ENERGY NEUTRON RESONANCES IN ERBIUM AND GADOLINIUM.
H.B.Møller, F.J.Shore and V.L.Sailor.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 183-92 (Sept., 1960).
The two neutron resonances in Er at 0.46 and 0.58 eV were measured using samples enriched in Er^{166}, Er^{167} and Er^{168}. It was found that both resonances occur in the target nucleus Er^{167}. The isotopic cross-sections of Gd^{155} and Gd^{157} were measured from 0.02 to 0.30 eV and resonances were found in Gd^{155} at 0.0268 and in Gd^{157} at 0.0314 eV. Parameters for these resonances were derived by fitting the data to single-level Breit–Wigner formulae. Isotopic assignments were made for fifteen Gd resonances between 1 and 25 eV from previously unpublished data using samples enriched in 155, 156, 157 and 158. The Breit–Wigner parameters for three of these were obtained.

17124 SURFACE DIRECT INTERACTION OF 14 MeV NEUTRONS WITH FLUORINE.
E.Kondaiah, M.L.Jhingan and C.Badrinathan.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 166-76 (Sept., 1961).
The energy and angular distribution of charged particles arising when 14 MeV neutrons are incident on a foil of Teflon were studied using a nuclear-emulsion detector. The energy distribution showed three peaks at 530, 220 and 120 μ ranges. The energies of these peaks (assuming them to be comprised of protons, deuterons or tritons) are given and they agree with those to be expected from known levels of the final nuclei. In general the emission at forward angles is found to be much more than at backward angles and it is (5.5 ± 0.5) times that at backward angles for all the three groups taken together. Experimental angular distributions of all the three groups are given. In two cases, these distributions are compared with theoretical distributions assuming surface direct interactions to be taking place. The agreement between theory and experiment is good enough to draw conclusions regarding parities of the levels involved. The energy and angular distributions of one of these groups indicate a new level in O^{19} at 4 MeV.

17125 ABSORPTION CROSS SECTION OF GRAPHITE. P.F.Nichols.
Nuclear Sci. Engng (USA), Vol. 7, No. 5, 395-9 (May, 1960).
A direct measurement of the graphite absorption cross-section

was made in the Physical Constants Testing Reactor (PCTR). The sample tested was reactor grade (GBF) graphite, and had a 2200 m/sec absorption cross-section of 3.80 ± 0.04 mb including all impurities. This measurement also provides a normalization for the Hanford Test Reactor relative measurement which has been in progress for over fifteen years. Samples of American, French, and British graphite were also tested in the HTR to provide a basis for comparing the results of American, British, and French graphite absorption cross-section measurements. The graphite bars involved have also been tested at Harwell and Saclay.

17126 PARAMETERS OF THE Lu^{176} NEUTRON RESONANCE AT 0.142 eV. J.P.Roberge and V.L.Sailor.
Nuclear Sci. Engng (USA), Vol. 7, No. 6, 502-4 (June, 1960).

The total cross-section of Lu^{176} was measured over the range of neutron energies from 0.02 to 0.25 eV. The data were taken with a sample enriched to 70.2% in Lu^{176}. The resonance at 0.142 eV in Lu^{176} was fitted to a Breit–Wigner single-level formula by the method of shape analysis. Parameters are presented for computing the activation cross-section as a function of neutron energy over the region of measurement.

17127 ANGULAR DISTRIBUTION OF 2.6 MeV GAMMA RAYS FROM THE REACTION Pb^{208} $(n,n'\gamma)$ Pb^{208}. D.J.Donahue.
Phys. Rev. (USA), Vol. 124, No. 1, 224-6 (Oct. 1, 1961).

Gamma rays produced through inelastic scattering by lead of a collimated beam of fast neutrons from a reactor were detected with a NaI(Tl) crystal. The relative yield of 2.6 MeV γ-rays from Pb^{208} was measured as a function of the angle between the incident neutrons and outgoing γ-rays. Good agreement is obtained between the experimental angular distribution and a calculated distribution based on a statistical model, and using quantum numbers 3^- for the 2.6 MeV state in Pb^{208}.

17128 THE RATIO OF THE RESONANCE INTEGRAL TO THE THERMAL NEUTRON CROSS SECTION FOR Sm^{152}. W.H.Walker and R.E.Green.
Canad. J. Phys., Vol. 39, No. 8, 1184-92 (Aug., 1961).

Cadmium ratio measurements were made in similar lattice positions in ZEEP with thin foils of Sm^{152} and gold. From a comparison of these cadmium ratios it was found that $(I'/g\sigma_0) = 14.65 \pm 0.41$ for Sm^{152}. If $g\sigma_0$ is assumed to be 212 ± 12 barns, then $I' = 3100 \pm 200$ barns. On the assumption that only one resonance in Sm^{152}, at 8 eV, contributes appreciably to both the resonance integral and the thermal cross-section, it follows that $g = 1$ and that Γ, the width at half-maximum of the total cross-section resonance, is 193 ± 5 meV. Because of the appreciable disagreement between this value and one reported earlier, a new time-of-flight measurement of the resonance parameters has been made, and it is reported in the next paper (see following abstract).

17129 RESONANCE PARAMETERS FOR THE 8-eV LEVEL OF Sm^{152}. R.E.Chrien.
Canad. J. Phys., Vol. 39, No. 8, 1193-6 (Aug., 1961).

The joint BNL–AECL Fast Chopper Facility operating at the NRU reactor at Chalk River was used to determine the resonance parameters of the 8 eV level of Sm^{152}. Using a resonance shape analysis method, the following parameters were obtained: $E_0 = 8.02 \pm 0.02$ eV, $\Gamma = 205 \pm 15$ meV and $\Gamma_n = 79 \pm 3$ meV. With these values, a reduced resonance capture integral of 3090 ± 220 barns is calculated, in agreement with recent cadmium ratio measurements (see preceding abstract).

17130 THE THERMAL NEUTRON ABSORPTION CROSS-SECTION OF ^{233}Th AND THE RESONANCE INTEGRALS OF ^{232}Th, ^{233}Th AND ^{59}Co.
F.J.Johnston, J.Halperin and R.W.Stoughton.
Reactor Sci. (GB), Vol. 11, No. 2-4, 95-100 (Feb., 1960).

The thermal neutron absorption cross-section of Th^{233} and the resonance absorption integrals of Th^{232}, Th^{233} and Co^{59} were measured as 1450, 85, 400 and 75 barns, respectively, by neutron activation measurements using cadmium filters with reactor spectrum neutrons.

17131 THERMAL NEUTRON CROSS-SECTION MEASUREMENTS OF U^{233}, U^{235}, Pu^{240}, U^{234}, AND I^{129} WITH THE O.R.N.L. FAST CHOPPER TIME-OF-FLIGHT NEUTRON SPECTROMETER. R.C.Block, G.G.Slaughter and J.A.Harvey.
Nuclear Sci. Engng (USA), Vol. 8, No. 2, 112-21 (Aug., 1960).

Measured over an energy range from approximately 0.02 to 0.20 eV. The cross-section data have been fitted in the energy range from approximately 0.02 to 0.04 eV by the least squares method to the following equation:

$$(\sigma_T - \sigma_{sc}) = \frac{a}{\sqrt{E}} + b,$$

where σ_T and σ_{sc} are the total and scattering cross-sections, E the neutron energy, and a and b are the coefficients of fit. From this least squares fit, the 2200 m/sec neutron total cross-sections of U^{233}, U^{235}, Pu^{240}, U^{234}, and I^{129} were determined to be 587 ± 3, 693 ± 5, 290 ± 8, 110 ± 4, and 35 ± 4 barns, respectively. A brief description of the spectrometer is included.

17132 TOTAL EFFECTIVE CROSS-SECTION OF VANADI AS A FUNCTION OF TEMPERATURE.
P.Denis and D.Roux.
Arch. Sci. (Switzerland), Vol. 13, No. 4, 574 (Oct.-Dec., 1960).
In French.

Reports preliminary experiments which are believed to ind a change of cross-section with temperature, which was forecas Cassel (Progress in Nuclear Physics, Vol. I). The experiment were carried out with the reactor of the University of Geneva a will be followed up elsewhere using a reactor of greater power J.Th

17133 REACTIONS LEADING TO THE FORMATION OF T Pb^{205m} ISOMER.
V.L.Glagolev, A.M.Morozov and P.A.Yampol'ski.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1621-4 (Dec., 19
In Russian.

More accurate data on the short-lived γ-radiation emitted from thallium irradiated by 19.2 MeV protons and 14.7 MeV neutrons are presented. It is demonstrated that the observed radiation is from the Pb^{205m} isomer. The cross-sections for th production of Pb^{205m} nuclei in proton and neutron reactions are measured. Calculations show that about half of the Pb^{205} nuclei produced in the Pb^{206} (n, 2n) reaction are produced in the metas state. [English translation in: Soviet Physics–JETP (USA), V No. 6, 1131-3 (June, 1961)].

Due to Mesons and Hyperons

17134 THE ANGULAR DISTRIBUTION AND POLARIZATI OF THE NEUTRONS THAT ARE EMITTED IN μ CAPTURE IN CERTAIN LIGHT NUCLEI.
M.K.Akimova, L.D.Blokhintsev and É.I.Dolinskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1806-17 (Dec., 1
In Russian.

The energy spectra, angular distributions, and polarizatio calculated for the neutrons produced in the direct process of μ capture in the nuclei C^{12}, Ne^{20}, Si^{28}, and S^{32}. The calculations a made on the basis of an effective Hamiltonian for μ capture tha takes into account first-order (v/c) effects for the nucleons, including "weak magnetism" and the effective pseudoscalar int action. The state of the protons in the nucleus is described by nuclear shell model with jj coupling; the interaction of the eme neutron with the nucleus is taken into account by the use of the optical model. The results are compared with the experimenta [English translation in: Soviet Physics–JETP (USA), Vol. 12, 1260-8 (June, 1961)].

17135 PRODUCTION OF NUCLEAR FRAGMENTS IN PHOTOGRAPHIC EMULSION BY 80 MeV POSITIV PIONS. A.S.Assovskaya and N.S.Ivanova.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1511-16 (Dec., 1
In Russian.

The production of multiply-charged particles by comparat low-energy (80 MeV) π^+ mesons was investigated with nuclear emulsions. An analysis of the charge, energy, and angular dis tions of the fragments and a comparison of the experimental d with calculations indicate that at the given incident meson ene the fragments are produced only by fast protons generated wit the nucleus as a result of π^+ absorption by a nucleon pair (n,p) experimental results show that there is a possibility that the fragments are knocked out by these protons. [English transla Soviet Physics–JETP (USA), Vol. 12, No. 6, 1051-4 (June, 196

7136 THE INTERACTIONS OF π^--MESONS WITH COMPLEX NUCLEI IN THE ENERGY RANGE (100-800) MeV.
'HE INTERACTION LENGTHS AND ELASTIC SCATTERING OF MeV π^--MESONS IN G5 EMULSION.
Allen, A.J.Apostolakis, Y.J.Lee, J.V.Major and E.P.Ferreira.
Mag. (GB), Vol. 6, 833-8 (July, 1961).
For Pt I see Abstr. 20185 of 1960. A total of 100.5 m of track was scanned in a block of emulsion exposed to the 750 MeV π^- -meson of the Brookhaven cosmotron. Allowing for the beam contamination of 7%, the interaction lengths for the production of inelastic ts and for elastic scattering with projected angles of $2 \leq \phi < 10^0$ 43.6 ± 2.9) cm and (66.8 ± 5.6) cm respectively. The geometric interaction length is 29.3 cm. A comparison with the optical of the nucleus gives a value for the absorption coefficient 1.5 ± 0.2) 10^{12} cm^{-1} and for the change in wave number 1.84 ± 0.06) 10^{12} cm^{-1}. The absorption coefficient corresponds mean free path in nuclear matter λ_n = (6.7 ± 0.9) 10^{-13} cm, to naginary component of potential V_i = (15 ± 2) MeV and with the va of the change in wave number to a real potential V_r = (36 ± 1) MeV.

7137 A CONTRIBUTION TO RESEARCH INTO INTERACTION BETWEEN π-MESONS AND ATOMIC NUCLEI.
ček.
h. J. Phys., Vol. 11, No. 6, 459-61 (1961).
An analysis was carried out on 420 emulsion stars produced by eV π^--mesons. The data were examined for correlations een the numbers of evaporation tracks, emitted protons, and ted π-mesons which might have shed some light on possible anisms of disintegration. However the average number of ted protons appeared to be independent of both the number of ed π-mesons and the number of evaporation tracks.
J.D.Dowell

e to Deuterons

7138 ANALYSIS OF ELASTIC AND INELASTIC SCATTERING OF 19 MeV DEUTERONS BY C^{12}.
alá, E.Villar, A.García, F.Senent and J.Aguilar.
Real Soc. Espan. Fis. Quim. (Spain), Vol. 56A, No. 11-12, 300 (Nov.-Dec., 1960). In Spanish.
The angular distributions were obtained by a photographic od and the following values of the interaction radius R calculated: (1) C^{12} fundamental level (spin 0, parity +), R_{el} = 5.44 ± 0.59 is (nuclear optical model, Fraunhofer diffraction for strongly rbing disk); (2) 4.55 MeV level (spin 2, parity +), R_{in} = 4.5 fer- (Huby—Newns direct interaction theory) and 5.0 fermis tern—Butler—McManus direct interaction theory); (3) 9.71 MeV (spin 1, parity -), R_{in} = 3.7 fermis (H.N. analysis), and 4.2 is (A.B.M. analysis). I.C.Demetsopoullos

7139 ELASTIC SCATTERING OF 13.6 MeV DEUTERONS. I.
Yu.V.Gofman and O.F.Nemets.
ksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1489-91 (Dec., 1960). ssian.
The angular distributions of 13.6 MeV deuterons scattered ically by Pb, Au, Pt, Sn, Ag, Ni, Cu, and Fe are studied. lish translation in: Soviet Physics—JETP (USA), Vol. 12, 5, 1035-6 (June, 1961)].

7140 ELASTIC SCATTERING OF 13.6 MeV DEUTERONS BY NUCLEI. II. Yu.V.Gofman and O.F.Nemets.
ksper. teor. Fiz. (USSR), Vol. 40, No. 2, 477-8 (Feb., 1961). ssian.
For Pt I see preceding abstract. The angular distributions elastic scattering on U, Bi, Cd, Zr, Nb, Zn, Ti, Si, Al and C i were measured. [English translation in: Soviet Physics— P (USA), Vol. 13, No. 2, 333-4 (Aug., 1961)].

7141 A SEARCH FOR FINE STRUCTURE IN THE REACTIONS $B^{10}(d,\alpha_0)Be^8$ AND $B^{10}(d,\alpha_1)B^{8*}$.
.Legge.
ear Phys. (Internat.), Vol. 26, No. 4, 608-15 (Sept., 1961).
The excitation functions for these reactions were measured keV steps of deuteron energy from 400 to 900 keV. The alpha cles were detected at 45° with a thin CsI(Tl) crystal and multiplier. No fine structure was observed in either reaction. bsolute values of the differential reaction cross-sections ° (lab.) angle are found to be 0.24 ± 0.05 mb/sr for the ground-state group and 1.25 ± 0.4 mb/sr for the group going to the first excited state in Be^8, both cross-sections being measured at a deuteron energy of 780 keV. The alpha-particle spectrum, as measured with 5½% energy resolution and I½% statistics, shows no sign of any Be^8 state between 3 and 5 MeV.

17142 THE REACTION B^{11} (d,t) B^{10}.
N.A.Vlasov, S.P.Kalinin, A.A.Ogloblin and V.I.Chuev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1618-20 (Dec., 1960). In Russian.
The B^{11} (d,t) B^{10} reaction was studied for 20 MeV deuterons. In accordance with the level scheme of the B^{10} neucleus, excitation of the lower levels of B^{10} occurs as a result of ejection of a neutron with $l = 1$. The probability of the ground state is several times higher than that of the excited states. The reduced widths from the reactions B^{11} (d,t) B^{10} and Be^9 (d,n) B^{10} are compared. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1129-30 (June, 1961)].

17143 THE ANGULAR CORRELATION (d, pγ) IN THE REACTION Be^9(d, p) Be^{10}.
S.Gorodetzky, J. Samuel and A.Gallmann.
J. Phys. Radium (France), Vol. 21, No. 5, 349-50 (May, 1960). In French.
Low and Mean Energy Nuclear Physics Colloquium, Grenoble 1960 (see Abstr. 12029 of 1961). In order to test the predictions of the distorted-wave theory of stripping reactions, the angular correlation Be^9(d, pγ) Be^{10} was measured in the reaction plane (d,p), at E_d = 5.5 MeV for the first excited level of B^{10}, at $\Phi_p = 50^0$, outside the peak of the angular distribution of protons coming from this level. The preliminary results indicate: (1) a slight shift of the summetry axis of the curve, which is no longer in the recoil direction; (2) a certain attenuation of the correlation compared with the one measured at the peak. However, definite conclusions will only be possible after the statistics have been improved by further measurement. The present result:

$$W(\Phi) = 1 - (0.315 \pm 0.066) \cos^2 (\Phi - \Phi_0)$$

where $\Phi = + (11 \pm 6.5)^0$

is not in contradiction with that obtained at 3.5-3.9 and 7.8 MeV by other authors.

17144 STRIPPING REACTIONS ON Cu^{12}, O^{16}, AND Si^{28}.
N.V.Alekseev, K.I.Zherebtsova, V.F.Litvin and Yu.A.Nemilov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1508-10 (Dec., 1960). In Russian.
The energy spectra and angular distributions of protons from the reactions C^{12}(d,p)C^{13}, O^{16}(d,p)O^{17} and Si^{28}(d,p)Si^{29} were studied for proton energies from 3 to 15 MeV, using 6.3 MeV bombarding deuterons. A new magnetic analyser, the multispectrograph, yields simultaneously the energy spectra of reaction products emitted at different angles. By comparing the observed angular distributions with stripping theory it was possible to derive the parities, spins, and reduced widths for a number of levels of the final nuclei. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1049-50 (June, 1961)].

DEUTERON- AND TRITON-INDUCED REACTIONS IN MAGNESIUM. See Abstr. 16987

17145 THE ^{55}Mn(d,p)^{56}Mn REACTION.
A.W.Dalton, G.Parry, H.D.Scott and S.Swierszczewski.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 404-8 (Sept., 1961).
The energy spectra of the protons emitted from a manganese target when bombarded with 8.9 MeV deuterons were measured by magnetic analysis at angles of observation between 5° and 60°. Angular distributions of a number of proton groups were obtained and compared with theoretical stripping curves to obtain information on parities, spins and reduced widths. The results are also compared with those of Schiffer, Lee and Zeidman (Abstr. 13617 of 1959) on gross structure in the proton spectra.

17146 THE $N^{14}(d,\alpha)C^{12}$ GROUND-STATE REACTION IN THE ENERGY RANGE OF DEUTERON FROM 1.5 TO 3.0 MeV.
T.Ishimatsu.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1529-38 (Aug., 1961).
The angular distribution for the $N^{14}(d,\alpha)C^{12}$ ground-state reaction was obtained at seven deuteron energies between 1.5 and

3.0 MeV, and the excitation function for this reaction at the laboratory angle of 30° was determined in the same energy range of the deuteron. The angular distribution varies remarkably with deuteron energy, suggesting that the reaction proceeds mainly via compound nucleus formation. The energy dependence of the 30° differential cross-section and the total cross-section indicate the presence of overlapping resonances at the excitation energy of about 22.6 MeV in the compound nucleus, O^{18}.

17147 STUDY OF THE $O^{16}(d,n)F^{17}$ REACTION.
O.Dietzsch. Y.Hama, E.W.Hamburger and F. C.Zawislak.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 103-111(Sept., 1961).

The $O^{16}(d,n)F^{17}$ ground-state reaction was investigated from the threshold of 1.83 MeV to 2.4 MeV. The deuteron beam was produced by an electrostatic accelerator; the neutrons were detected by a long counter. Yield curves were obtained at three angles and angular distributions at seven energies. The angular distributions are isotropic near threshold but become quite anisotropic at higher energies; they are not symmetric about 90° and are suggestive of a direct-reaction mechanism. An attempt was made to explain the experimental results by stripping theory, taking the distortion of the deuteron wave by the Coulomb field into account. At low energies the calculation yields results in agreement with experiment, but a higher energies a large discrepancy exists. This disagreement appears to be related to the existance of resonances in the yield curve at the higher energies.

17148 STRIPPING REACTIONS OF THE Zr^{90} AND Zr^{91} NUCLEI. N.I.Zaika and O.F.Nemets.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1019-21 (April, 1961). In Russian.

The values of the transferred angular momenta, parities, and possible spins of the ground and excited states of the Zr^{90} and Zr^{91} nuclei are determined by comparing the experimental proton angular distributions in stripping reactions with the theory. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 716-17 (Oct., 1961)].

17149 THE REACTION (d,t) ON ZIRCONIUM ISOTOPES.
N.A.Vlasov, S.P.Kalinin, A.A.Ogloblin and V.I.Chuev.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1615-17 (Dec., 1960). In Russian.

The spectra of tritons of the reactions (d,t) on $Zr^{91, 92, 94}$ were investigated at E_d = 20 MeV. Two groups of tritons of different energy and angular distribution were produced on zirconium isotopes. One corresponds to the ejection of a neutron from the N = 50 filled shell, and the other to the ejection of an external neutron. The intensity of the latter groups is approximately proportional to the number of super-magic neutrons. The intensity of the first group slowly decreases from Zr^{90} to Zr^{94}. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1127-8 (June, 1961)].

Due to Alpha-particles

17150 SCATTERING OF 29 MeV He^3 PARTICLES BY CCl_4.
J.Catalá, A.Lleó, A.García, M.C.Altés and J.Aguilar.
An.Real Soc. Espan. Fis. Quim. (Spain), Vol. 56, No. 11-12, 301-5 (Nov.-Dec., 1960). In Spanish.

The angular distribution of the elastic scattering He^3—Cl was obtained by a photographic method and compared with that of the He^3-A^{40} scattering and with the theoretical distribution. A value 6.05 ± 0.37 fermis was obtained for the radius of interaction using the Fraunhofer diffraction formula for a strongly absorbing disk.
I.C.Demetsopoullos

17151 THE $T(\alpha,\gamma)Li^7$ REACTION.
G.M.Griffiths, R.A.Morrow, P.J.Riley and J.B.Warren.
Canad. J. Phys., Vol. 39, No. 10, 1397-1408 (Oct., 1961).

The $T(\alpha,\gamma)Li^7$ reaction was observed using thin targets of tritium absorbed in zirconium bombarded by singly charged helium ions of energy from 0.5 MeV to 1.9 MeV. The cross-section rises smoothly with energy in a fashion characteristic of a direct radiative capture process. The ratio of the intensities of transitions to the first excited state at 478 keV and to the ground state is 0.40± 0.05. The angular distribution is, to within errors, isotropic at E_α = 0.8 MeV but is significantly higher at 0° than at 90° for E_α = 1.6 MeV. The total capture cross-section at a mean alpha-particle energy in the target of 1.32 MeV is 3.58±0.60 microbarns and the corresponding astrophysical S factor is 0.064±0.016 keV barn in centre-of-mass system. The results are compared with recent theoretical results on the direct radiative capture process.

17152 STUDY OF NEUTRONS FROM A Po—F(α,n) SOURCE.
A.J.D.Szilvasi, K.W.Geiger and W.R.Dixon.
Reactor Sci. (GB), Vol. 11, No. 2-4, 131-5 (Feb., 1960).

The neutron spectrum of a Po—F(α,n) source was determined with nuclear emulsions. There is a single maximum occurring at about 1.3 MeV, and the maximum neutron energy is about 3 MeV. A study of the gamma rays from excited states in the residual Ne^{22} nucleus was made by taking neutron—gamma coincidences. The gamma ray spectrum thus found supports a recently published level scheme for Na^{22}. A calculation of the neutron spectrum, under certain simplifying assumptions, shows that this level scheme is compatible with the observed neutron spectrum.

Due to other Particles and Nuclei

17153 ON THE BOND IN THE C^{12}—C^{12} NUCLEAR MOLECULE.
A.S.Kompaneets.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1713-15 (Dec., 1960). In Russian.

It is shown that "molecular" states of two nuclei may exist as the result of a common orbit of a strongly excited neutron. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1196-7 (June, 1961)].

17154 EMISSION OF ELECTROMAGNETIC RADIATION IN COLLISIONS OF PARTICLES WITH SIMILAR VALUES OF e/m. E.I.Malkov and I.M.Shmushkevich.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1837-46 (Dec., 1960). In Russian.

The differential cross-section for bremsstrahlung in the collision of charged particles with equal or similar e/m values for which quadrupole radiation predominates is calculated. Formulae are obtained for the distributions in angle and energy and for the polarization, taking into account the quadrupole and dipole terms and their interference. The calculation is a classical one, which is valid for low frequencies and for sufficiently low energies of the colliding particles. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1282-7 (June, 1961)].

17155 NEUTRON EMISSION FROM STRONGLY EXCITED NUCLEI.
A.S.Karamyan, G.A.Dorofeev and D.S.Klochkov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1004-6 (April, 1961). In Russian.

The relative intensities and angular distributions of neutrons with effective energies of 10, 15 and 25 MeV produced by multiply charged ions in (C^{12}, xn, xp) and (O^{16}, xn, xp) reactions were investigated. The results are in satisfactory agreement with the predictions of the statistical model of nuclear reactions. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 705-6 (Oct., 1961)].

17156 ALPHA—DEUTERON MODEL OF THE Li^6 NUCLEUS AND THE $Be^9(Li^6,\alpha)B^{11}$ REACTION. M.L.Rustgi.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 58-65 (Sept., 1961).

The angular distributions of the particles emitted in (Li^6,α) and (Li^6,d) reactions are calculated under the assumption that they are stripping processes. An alpha—deuteron model of the Li^6 nucleus is used. The Coulomb effects of the interacting particles and the nuclear interaction between the outgoing particles are neglected. The derived fromulae are compared with the experimental data of Leigh and Blair (1961) on the differential cross-section of the $Be^9(Li^6,\alpha)B^{11}$ reaction. The general shapes of the calculated angular distributions are similar to those of the experimental data but there is a lack of agreement between theory and experiment for large angles.

17157 NEUTRON EMISSION FROM COMPOUND NUCLEAR SYSTEMS OF HIGH ANGULAR MOMENTUM.
H.W.Broek.
Phys. Res. (USA), Vol. 124, No. 1, 233-45 (Oct. 1, 1961).

Measurements were made of the energy spectra and angular distributions of neutrons emitted with laboratory energies in the

from 1 to 10 MeV in reactions induced by 160 MeV O^{16} ions
nt on thin targets of aluminium, nickel, copper, and gold.
a were obtained (at laboratory angles between 30° and 150°)
lysis of the proton-recoil pulse-height spectra produced by
ıtrons in a stilbene scintillation crystal. All spectra and
r distributions at these angles are consistent with the
esis of evaporation from compound nuclei. The energy spectra
ıtrons emitted from the initial compound nuclei were calcu-
y use of statistical evaporation theory, both with and without
cation to include (in a classical approximation) the effects of
ıvation of angular momentum. The dominant effect of conser-
of angular momentum upon the calculated neutron spectra
he initial compound nuclei is a lowering of the nuclear
ion temperature for the cases and parameters chosen. The
red spectra are compared to the spectra calculated both with
thout the modification. The angular distributions are symmet-
ıut 90° and peaked forward and backward. The total cross-
ı for neutron production increases with increasing mass of
ıget atom, and is roughly 70% greater for copper than for
. This sudden increase is probably related to the greater
n excess of copper.

lear Fission

158 THE ASYMMETRY OF NUCLEAR FISSION. B.T.Geilikman.
ıaya Energiya (USSR), Vol. 6, 290 (1959). In Russian. English
ation in: Reactor Sci. (GB), Vol. 12, No. 1-2, 55-61
1960).
n important quantity in nuclear fission and in the process
place in a nuclear reactor is the mass spectrum of fission
ents. The droplet model of the nucleus predicts a symmetric
ıution of masses as the most probable, but this contradicts
ıment. The mass distribution of fission fragments is
ated for several nuclei from the energy of the fissile nucleus
to cleavage, with due allowance for shell effects. It is shown
ıe energy minimum corresponds to asymmetric fission.

159 A NOTE CONCERNING THE PURELY PROTON MODERATED SPECTRUM. B.J.Toppel.
ır Sci. Engng (USA), Vol. 7, No. 5, 476-7 (May, 1960).
he collision density for moderation in a non-absorbing and
e medium of hydrogen is evaluated and plotted for the U^{235}
ı spectrum. J.H.Gunn

160 THE SPECTRUM OF NEUTRONS FROM THE IRRADIATION OF URANIUM BY 14 MeV NEUTRONS.
larke.
. J. Phys., Vol. 39, No. 7, 957-66 (July, 1961).
he spectrum and absolute yield of neutrons resulting from
V neutrons incident on natural uranium were observed at
16 to the incident neutron beam by a time-of-flight method.
er observations of the spectrum from 9 to 13.5 MeV were
for scattering angles at 30° and 60°. In addition to the expected
ons resulting from evaporation and fission, strong evidence is
or direct interaction inelastic scattering. The (n,n') cross-
n is estimated to be 150 ± 70 millibarns. See also following
ıct.

161 NEUTRON EVAPORATION IN THE 14 MeV NEUTRON FISSION OF URANIUM. G.C.Hanna and R.L.Clarke.
J. Phys., Vol. 39, No. 7, 967-75 (July, 1961).
he numbers of pre-fission and post-fission neutrons expected
he 14 MeV neutron fission of uranium were calculated from
perimental data on partial cross-sections and neutron multi-
es. It was assumed that the competition between neutron
ion and fission does not change with increasing energy beyond
ıold. The neutron energy spectrum measured recently by
e (see preceding abstract) gives a smaller intensity in the
v range 4-6 MeV than is expected from the calculated number
t-fission neutrons. The measured intensity suggests that only
0.5 neutrons are evaporated from the moving fission fragments.

162 EVALUATION OF LOW-ENERGY CROSS SECTION DATA FOR U^{233}. J.E.Evans and R.G.Fluharty.
ır Sci. Engng (USA), Vol. 8, No. 1, 66-82 (July, 1960).
study is made of available experimental data for the cross-
n and fission parameters for U^{233}. These data are used to
at recommended values of the parameters for 2200 m/sec
ons as follows: $\sigma_{nT} = 586 \pm 2$ b; $\sigma_{n,n} = 13 \pm 3$ b;
$\sigma_{nX} = 573 \pm 4$ b; $1 + \alpha = 1.0935 \pm 0.0038$; $\sigma_{n,f} = 524 \pm 4$ b;
$\sigma_{n,\gamma} = 49 \pm 2$ b; $\eta = 2.291 \pm 0.009$; $\nu = 2.50 \pm 0.012$. The methods used in deriving the recommended values are presented in detail and brief summaries of the measurements are included. Energy dependent absorption and fission data from 0.02 to 1 eV that have recently become available are presented.

17163 MANGANESE BATH MEASUREMENTS OF η OF U^{233} AND U^{235}.
R.L.Macklin, G.DeSaussure, J.D.Kington and W.S.Lyon.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 210-20 (Sept., 1960).
The absolute thermal value of η was measured directly by a method of total absorption which involves relative counting of manganese bath activations and some minor corrections. A thermal neutron beam (defined by cadmium difference) is introduced in the centre of a 1 m diameter sphere filled with a dilute solution of manganese sulphate in water. The beam is first made to activate the bath directly, then it is totally absorbed in the fissionable sample whose fission neutrons then activate the bath. The ratio of the two activities is equal to η except for small corrections. The results obtained for η corrected to 2200 m/sec were, for U^{233}, 2.296 ± 0.010; and for U^{235}, 2.077 ± 0.010.

16164 MEASUREMENTS OF Pu AND U^{235} FISSION RATES IN WATER–URANIUM REACTOR SPECTRA. D.Klein.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 405-9 (Nov., 1960).
Measurements of Pu^{239} and Pu^{241} fission rates relative to U^{235} were made in 1.3% enriched uranium metal fuelled lattices. Results were obtained in lattices having 0.387 in. diameter rods and water-to-uranium ratios of 2.35 : 1 or 1 : 1. The measurements are compared with a calculational model and the agreement is considered good.

17165 AN EXPERIMENTAL STUDY OF THE RELATIVE U^{235} FISSION ACTIVATION AS A FUNCTION OF ENERGY IN SLIGHTLY ENRICHED URANIUM–WATER LATTICES.
J.J.Volpe and D.Klein.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 416-25 (Nov., 1960).
Measurements of the relative U^{235} fission rates as a function of energy were made for the TRX facility, a slightly enriched uranium, light water moderated critical assembly. The parameter directly measured is the ratio of the activity of a bare U^{235} foil to that of a similar foil enclosed in a box of absorbing material, which was either cadmium, boron, or gadolinium. The energy dependence associated with these ratios was obtained by the introduction of "effective cutoff energies" for the absorbing shields. A comparison is made with calculated values, based upon a simplified model for the neutron energy spectrum present, and the agreement is considered adequate.

17166 A URANIUM-METAL EXPONENTIAL EXPERIMENT. C.G.Chezem.
Nuclear sci. Engng (USA), Vol. 8, No. 6, 652-69 (Dec., 1960).
Certain conflicts arising from previous measurements of neutron flux parameters in the equilibrium spectrum of natural uranium have been resolved. The parameters which were investigated are listed below along with "best" values as measured in this work.

Material buckling	-0.0119 ± 0.0005 cm^{-2}
Diffusion length	9.17 ± 0.18 cm
U^{235}/U^{238} fission cross-section ratio	239 ± 7
Pu^{239}/U^{238} fission cross-section ratio	250 ± 16
Np^{237}/U^{238} fission cross-section ratio	14.5 ± 0.5
U^{238} inelastic scattering cross-section	2.00 ± 0.04 barns

The experiment was performed at the Pajarito critical assemblies facility utilizing two exponential columns of natural uranium, each 30.7 in. high, having diameters of 15 and 21 in. and excited by a small fast reactor. The system was outdoors, elevated some 11 ft above the ground level to reduce flux perturbations due to back-scattering of neutrons. Perturbation corrected measurements in both columns made by several detection methods and with various source spectra agree to within experimental error and are consistent with calculated values.

17167 RADIOCHEMICAL STUDIES OF NEUTRON-INDUCED FISSION OF U^{235} AND U^{238} AND THE TWO-MODE FISSION HYPOTHESIS. H.B.Levy, H.G.Hicks, W.E.Nervik, P.C.Stevenson, J.B.Niday and J.C.Armstrong, Jr.
Phys. Rev. (USA), Vol. 124, No. 2, 544-51 (Oct. 15, 1961).
It has been suggested that the effect of changing excitation energy on the shape of the fission product mass-yield curve from

fission of a single nuclear species is due to the change in the relative amounts of two energy-independent modes of fission, each giving rise to its own characteristic mass-yield curve. It is shown here that this hypothesis predicts a linear relationship between the fission yields of any pair of fission products measured at a set of excitation energies. Linear relationships are also predicted between pairs of fission yields measured relative to the yield of some reference fission product. Fission product yields relative to the fission yield of Mo^{99} were measured for fission of U^{235} and of U^{238} with neutron beams of mean energies ranging from 2 to 10 MeV. The predicted linear relationships were observed in all cases. However results for fission yields from U^{235} with thermal neutrons do not fall on the corresponding observed lines. The two-mode fission hypothesis is a possible explanation for the linear relationships observed but does not explain all of the data.

17168 THE AVERAGE NUMBER OF NEUTRONS $\bar{\nu}$ FROM THE FISSION OF U^{235} AND U^{238} BY 14 MeV NEUTRONS.

N.N.Flerov and V.M.Talizin.
Atomnaya Energiya (USSR), Vol. 5, 653 (1958). In Russian. English translation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4, 169-71 (Feb., 1960).

Determined by measuring the increase in the neutron flux when a beam of 14 MeV neutrons is passed through samples of these materials. Details of the experimental technique are given and the formulae used to calculate $\bar{\nu}$ are provided. The values of $\bar{\nu}$ for U^{235} and U^{238} were found to be 4.50 ± 0.32 and 4.13 ± 0.24 respectively. The value of $\bar{\nu}$ for U^{238} has been confirmed by other workers but the value of $\bar{\nu}$ for U^{235} is less than that found by other workers.

B.Brown

17169 THE RATIO OF ASYMMETRIC TO SYMMETRIC FISSION IN p-WAVE NEUTRON FISSION OF U^{235}.

J.G.Cuninghame, G.P.Kitt and E.R.Rae.
Nuclear Phys. (Internat.), Vol. 27, No. 1, 154-65 (Sept., 1961).

Radiochemical measurements were made of the peak-to-valley ratio of the mass–yield curve for neutron induced fission of U^{235} at neutron bombarding energies from 65 keV to 14 MeV, with emphasis on the region about 125 keV. In this region, where p-wave interactions predominate, the peak-to-valley ratio was found to be $\cong 45\%$ higher than for thermal neutron fission, contrary to the trend suggested by the channel theory of fission.

17170 THE SYSTEMATICS OF THE PROMPT FISSION NEUTRON SPECTRUM. V.P.Kovalev and V.S.Stavinsky.
Atomnaya Energiya (USSR), Vol. 5, 649 (1958). In Russian. English translation in: Reactor Sci. Technol. (GB), Vol. 11, No. 2-4, 166-9 (Feb., 1960).

It was experimentally established that the fission neutron spectra of U^{233}, Pu^{239} and Cf^{252} consist of harder neutrons than the fission spectrum of U^{235} and that the hardness increases from the spectrum of U^{233} to the spectrum of Cf^{252}. In the present paper the evaporation model is used in an attempt to generalize the experimental data on fission neutron spectra. A detailed analysis of the fission neutron spectrum is made and shows that within the framework of the evaporation model applied to moving fragments, both the shape of the fission spectrum and the observed difference between such shapes for reasonable parameters of the theory can be explained.

B.Brown

17171 THE FISSION CROSS-SECTIONS OF ^{233}U AND ^{235}U FOR NEUTRONS HAVING ENERGIES BETWEEN 3 AND 800 keV.

G.V.Gorlov, B.M.Gokhberg, V.M.Morozov, G.A.Otroshchenko and V.A.Shigin.
Atomnaya Energiya (USSR), Vol. 6, 453 (1959). In Russian. English translation in: Reactor Sci. (GB), Vol. 12, No. 1-2, 79-82 (May, 1960).

The effective cross-sections are presented for neutrons obtained from the $T(p,n)He^3$ reaction in an electrostatic accelerator. The fission cross-section of U^{233} falls from 7.5 barns at 3.4 keV to 1.9 barn at 780 keV; the corresponding values for U^{235} are 4.8 and 1.05 barn, respectively.

17172 THE VALUE OF ν FOR FISSION SPECTRUM INDUCED AND SPONTANEOUS FISSION OF ^{238}U.

R.Sher and J.Leroy.
Reactor Sci. (GB), Vol. 12, No. 3, 101-7 (June, 1960).

The effective value of ν for U^{238} fission induced by a fission spectrum of fast neutrons was measured by the "scattering" technique and, much more accurately, by the "coincidence" technique. The result for the ratio of ν_{238}/ν_{235} (thermal) agrees with earlier values of comparable precision reported in the literat and, when averaged with them, yields a best value for this ra 1.160 ± 0.020. If ν_{235} (thermal) is 2.47 ± 0.03, the best value ν_{238} (fission spectrum) is 2.86 ± 0.05. A probable explanation suggested for the apparently high value of ν_{238} (3.5 ± 0.2) rep in an earlier experiment. The value of ν_{238} for spontaneous f of U^{238} was also obtained. The result 2.10 ± 0.08 (based on ν (thermal) = 2.47) agrees with earlier values in the literature derived from separate measurements of neutron emission an spontaneous fission rates in U^{238}.

17173 EFFECTIVE FISSION AND CAPTURE CROSS-SECTIONS FOR HARDENED MAXWELLIAN NEU SPECTRA. C.H.Westcott.
Reactor Sci. (GB), Vol. 12, No. 3, 113-21 (June, 1960).

Although a "hardening" of the thermal neutron spectrum the fuel of a heterogeneous reactor, due to the selective abso of the slower neutrons, is known to occur, its effect on the ef cross-sections to be used is frequently ignored. Sometimes treated as the equivalent of raising the neutron temperature, the present work examines this approximation. For a genera treatment, two simple geometries only are considered, but t cross-sections of a number of important isotopes, including and Pu^{239} and the reactor poisons Sm and Gd, which depart fr the "1/v-law", are studied. The hardening effect is found, as expected, to be largest for nuclei whose effective cross-secti vary most rapidly with the temperature of the neutrons, but t is no simple rule relating the effect of hardening with the cha neutron temperature which would give the same change in eff cross-section. The numerical results of these calculations a therefore given in the form of sets of coefficients for a doubl power-series in temperature and flux-depression due to the causing the spectral hardening; the coefficients were obtaine least-squares fitting to our results and an accuracy of fit wa obtained which is adequate for any reasonable use of the info

17174 GAMMA RADIATION FROM U^{235} AND Pu^{239} FISSI FRAGMENTS. Yu.I.Petrov.
Atomnaya Energiya (USSR), Vol. 7, 168 (1959). In Russian. translation in: Reactor Sci. Tehhnol. (GB), Vol. 12, No. 3, 1 (June, 1960).

The γ-radiation from U^{235} and Pu^{239} fission fragments ha studied at times from 0.6 sec to 11 hr after pulsed irradiatio targets by a flux of thermal neutrons in a heavy water reacto using air-equivalent ionization chambers and a Geiger counte kinetics of short-period γ-radiation from fission fragments shown graphically. The spatial distribution of γ-radiation in for energies of 0.41, 1.25, and 2.8 MeV is also shown. The t yield of γ-radiation energy in 1 sec after one fission has bee mined by three independent methods and the results agree re ably well.

17175 THE EXCITATION ENERGIES OF FISSION FRA B.T.Geilikman.
Atomnaya Energiya (USSR), Vol. 6, 298 (1959). In Russian. translation in: Reactor Sci. (GB), Vol. 12, No. 1-2, 62-8 (Ma

The multiplication factor of a nuclear chain reaction dep very strongly on the number of neutrons emitted in fission, a this number in turn is determined by the excitation energies the fragments. It is therefore of some value to calculate the energies as functions of the Z and A of the dividing nucleus. shown that the energies can be found by solving a system of for the deformation parameters and for the distance between fragments. Initial boundary conditions for this system of equ are derived, and the excitation energies of the fragments are for certain nuclei. The way the energy depends on Z and A i investigated.

17176 FISSION OF ANTIMONY BY HIGH-ENERGY PR A.K.Lavrukhina, É.E.Rakovskii, Su Khun-Gui [Su Hung-Kuei] and S.Khoinatskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 409-18 (Feb., In Russian.

The fission of antimony nuclei induced by 660 MeV prot studied. The fission yields as function of A and Z are single humped curves. The highest production probabilities are ob for isotopes lying near the nuclear stability line. The fissio mainly symmetric, and is accompanied by the emission of a number of charged particles. At E_p = 660 MeV the total fiss cross-section is 0.25 mb. Neutron-deficient isotopes are pr relatively more frequently by fissioning antimony than by he

The relative number of asymmetric fissions diminishes creasing incident proton energy. The principal character- of fast-proton fission are shown to vary regularly with sing Z of the target nucleus. [English translation in: Soviet s—JETP (USA), Vol. 13, No. 2, 280-6 (Aug., 1961)].

77 SOME FEATURES OF MULTIPLE PRODUCTION OF FRAGMENTS BY 9 BeV PROTONS.
richev, O.V.Lozhkin, G.A.Perfilov and Yu.P.Yakovlev.
sper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 327-33 (Aug., 1961).
ian.
estigates the disintegration of Ag and Br nuclei induced by protons and accompanied by the emission of two or more harged particles (Z=3 to 9). Various characteristics of mul- nission of the fragments such as the probability for disinteg- with emission of N_ϕ fragments, the charge and energy dis- ns of the fragments and their angular correlations are d. It is concluded that multiply produced fragments are l independently. [English translation in: Soviet Physics— USA)].

78 THE Xe^{135} YIELD IN THERMAL FISSION OF Pu^{239}.
J.G.Bayly, M.R.Duret, N.B.Poulsen and R.H.Tomlinson.
J. Phys., Vol. 39, No. 9, 1391-3 (Sept., 1961).
e data of Fickel and Tomlinson (Abstr. 11490 of 1959) is A correction for neutron absorption in Xe^{135} produces a more te result for the yield. The total Xe^{135} produced was 37% than the measured Cs^{135} yield. It is estimated that the ield is 7.43%, based on an absolute yield of Cs^{133} of 6.90%.
A.J.Salmon

79 THE STABILITY OF "STABLE" FISSION-PRODUCT POISONING.
nst, J.C.Connor and E.Fast.
r Sci. Engng (USA), Vol. 8, No. 2, 128-32 (Aug., 1960).
reactor-lifetime calculations it is customary to take account ransient behaviour of two fission-product poisons, Xe^{135} and and to assume the gross poisoning due to all other products nction of the total time-integrated exposure irrespective detailed flux history. This description tacitly assumes that ss poisoning of the other products is stable. The adequacy description is demonstrated experimentally for a natural mple irradiated in a reactor flux of 2×10^{14} n cm^{-2} sec^{-1} to osure of 6300 Mwd/ton. The poisoning associated with the ed "stable" fission products is found to change only 3) barns per fission per year.

rmonuclear Reactions

80 ENERGY DISTRIBUTION OF NEUTRONS PRODUCED BY A THERMONUCLEAR REACTION.
ust and E.G.Harris.
r Fusion (Internat.), Vol. 1, No. 1, 62-3 (Sept., 1960).
e energy distribution of neutrons in a thermonuclear reaction ulated. It is assumed that the reacting mixture of gases is in dynamic equilibrium and that the differential cross-section tron production is isotropic in the centre of mass system.

NUCLEAR POWER STUDIES

81 CONSIDERATIONS IN THE DESIGN OF A NUCLEAR ROCKET. J.J.Newgard and M.M.Levoy.
r Sci. Engng (USA), Vol. 7, No. 4, 377-86 (April, 1960).
e over-all design of a prototype nuclear rocket is described. actical systems using uranium-loaded graphite for fuel ts within a graphitic core structure, and hydrogen as core and propellant, it is possible to achieve specific impulses ast 800 sec. The design of the reactor core, reflector, and controls are presented for a prototype design. The nuclear, ansfer, and fluid flow considerations for a typical design are sed. Reactor perturbations caused by fuel element ejection, ion-erosion, and hydrogen density changes are discussed. adiation hazards are considered. Non-reactor aspects of the such as hydrogen handling and the coupling of the reactor rocket system are indicated.

17182 GODIVA II — AN UNMODERATED PULSE-IRRADIATION REACTOR.
T.F.Wimett, R.H.White, W.R.Stratton and D.P.Wood.
Nuclear Sci. Engng (USA), Vol. 8, No. 6, 691-708 (Dec., 1960).
Design features of Godiva II, are discussed together with characteristics of power excursions, and performance is compared with that of the original Godiva. Measurements of the wait time between stepwise reactivity insertion and the occurrence of a burst are presented and compared with theory based on a statistical model of fission chains. Analytical and numerical solutions of the reactor equations are developed to reproduce experimental data and extrapolate to higher energy release. Consideration is also given to perturbations arising from room-returned neutrons. Two different modes of operation are discussed and some design problems of Godiva-type pulsed reactors are briefly mentioned. Typical bursts are illustrated with peak powers up to 13 000 MW and widths at half-maximum down to 35 μsec.

NUCLEAR ENERGY IN SPACE. See Abstr. 15578-81

17183 THE CRITICAL PROBLEMS FOR MULTILAYER SLAB SYSTEMS. A.Kuszell.
Acta phys. Polon. (Poland), Vol. 20, No. 7, 567-89 (1961).
Uses the procedure developed by Case (Abstr. 3471 of 1960) for the one-velocity Boltzmann equation with isotropic scattering of the neutrons. In all the cases considered, the solution of the Boltzmann equation is reduced to the solution of a one-dimensional Fredholm-type integral equation with an additional critical condition.

17184 THE CRITICALITY CONDITION OF A CYLINDRICAL HETEROGENEOUS REACTOR, WITHOUT REFLECTOR, IN THE MULTIGROUP THEORY. M.Angelopoulos.
Atomkernenergie (Germany), Vol. 5, No. 1, 7-9 (Jan., 1960).
In German.
Derived from the criticality condition for stability. The problem is treated by the general case of elementary multigroup diffusion theory. The system of differential equations for the n groups is solved in the non-steady case, making use of the appropriate integral transformations, and thereby the condition for a steady state flux distribution is derived.

17185 FAST AND THERMAL NEUTRON FLUX AT THE SURFACE OF CYLINDRICAL CONTAINERS AS THE RESULT OF N^{17} ACTIVITY INDUCED IN WATER. W.Kattwinkel.
Atomkernenergie (Germany), Vol. 5, No. 1, 9-13 (Jan., 1960).
In German.
Calculated by means of 2-group diffusion theory. The following cases are discussed: (a) an infinite cylinder, and specific activity constant in all parts of it, (b) a finite cylinder, and specific activity constant in all parts of it, (c) a finite cylinder, and specific activity proportional to $e^{-\alpha z}$. Comparison with other results (Abstr. 627 of 1961) shows that the γ-activity induced in water is initially responsible for the dose rate at the surface.

17186 INVESTIGATION OF AN INFINITELY LARGE, UNMODERATED, HOMOGENEOUS, CRITICAL REACTOR ASSEMBLY. J.J.Schmidt.
Atomkernenergie (Germany), Vol. 5, No. 7-8, 245-56 (July-Aug., 1960). In German.
Deals, within the scope of the integral equation theory for fast reactors, with the limiting case of an infinite, unmoderated, critical reactor, homogeneously composed of fissionable, fertile and cooling material. The integral equation for the neutron energy spectrum of such an assembly is derived, and solved approximately by a matrix iteration method. The data thus obtained are characteristic of the neutron economy of the infinite reactor and are compared with the corresponding values for finite fast reactors. The behaviour of neutrons in an unmoderated reactor is thereby studied, in the energy range 10^{-4} to 10 MeV, as a function of the fraction of cooling and fertile material. In particular, the influence on neutron energy distribution and on the relation between neutron energy spectrum and fission spectrum at high neutron energies, of the (n, 2n) process in U^{238}, of inelastic neutron retardation by U^{238}, and of elastic neutron scattering in Na is evaluated. Finally, the calculations on the Z 22 electronic computer are discussed and the advantages and disadvantages of the matrix iteration method used, against the usual theory of multigroup diffusion, are explained.

17187 ON THE THEORY OF "SPIKING" IN NEUTRON MULTIPLYING SYSTEMS. S.E.Corno.
Nuovo Cimento (Italy), Vol. 21, No. 3, 484-99 (Aug. 1, 1961).
The main purpose of the work is to develop a theory suitable for

dealing with those neutron multiplying structures in which a small number of highly reactive blocks, the so called "spikes", are embedded into a finite subcritical medium; this basic medium is assumed to be homogeneous from the standpoint of neutron migration and multiplication. It is shown how the theory can be worked out by performing a proper inversion of the integral operator, which describes the thermal flux distribution. The problem is solved by giving it the same form which one encounters when treating, along the lines of the heterogeneous theory, a "reactor with a small number of blocks". Cylindrical multiplying structures are examined in great detail: the resulting treatment, within the limits of the age-diffusion or multigroup theory, can be considered as the exact one, at least for those systems in which the spikes can be taken as line singularities of the neutron field. Spiked structures, even if the basic multiplying medium is left unchanged, possess as many degress of freedom as the number of "classes" of spikes which constitute the system, times the number of parameters charactering each spike. An optimization theory is worked out for such types of nuclear reactors in order to fulfill, by a proper choice of the free parameters, the criticality condition together with a set of additional requirements.

17188 THE TIME-DEPENDENT IMPORTANCE OF NEUTRONS AND PRECURSORS. J.Lewins.

Nuclear Sci. Engng (USA), Vol. 7, No. 3, 268-74 (March, 1960).

The concept of the adjoint neutron density is extended to a time-dependent field. The importance of neutrons and precursors is defined as the contribution of each to some final arbitrarily selected detectable process. An axiom is given which expresses the consistency requirement for such a definition. From this axiom, the equations and boundary conditions for the importance in the diffusion approximation are derived. The nature of the solutions to these equations is considered with particular regard to the time-dependent behaviour of the importance. Several normalizations or final boundary conditions are proposed which include as special cases the conventional interpretations of the adjoint function in a just-critical reactor. In particular, for a noncritical reactor, the equivalence is introduced as the number of neutrons and precursors distributed in the persisting solution that would replace one neutron or precursor with equivalent asymptotic results.

17189 VARIATIONAL REPRESENTATIONS IN REACTOR PHYSICS DERIVED FROM A PHYSICAL PRINCIPLE. J.Lewins.

Nuclear Sci. Engng (USA), Vol. 8, No. 2, 95-104 (Aug., 1960).

A physical axiom is advanced that relates to the density of neutrons and their individual contribution to the operationally determinable behaviour of a reactor. The variational principle derived from this axiom is of a general form applicable to systems in which the time dependency of the coefficients of the equations prevents a separation into conventional eigenfunctions and eigenvalues. The physical significance of the independent variation of two field functions is investigated. The treatment of the nonseparable systems and the variational principle to which one is led are both independent of any particular physical model employed to represent the system and appear to be applicable to a variety of nonconservative, continuous, and time-dependent systems in mathematical physics. The more well-known properties of the separable problem are derived from the principle as "the exception proving the rule" in an attempt to associate physical meaning with the commonly employed forms. Thus a discussion is given of the relation of the Green's function to both fields and the Joint Error is introduced as a criterion for the completeness of biorthogonal sets. Although the variational principle derived is not applicable to variation of the coefficients of the equations through nonlinearities, it is indicated how the present approach may be extended to account for nonlinearities. (See also preceding abstract).

17190 SURFACE PERTURBATION THEORY. J.Lewins.

Nuclear Sci. Engng (USA), Vol. 7, No. 6, 481-6 (June, 1960).

A surface perturbation method to determine reactivities is described which has application to the removal of reflectors, the lowering of water levels in reactors, the introduction of voided beam tubes, the insertion of black control rods, etc. A first-order approximation, using the unperturbed flux in the calculations, is shown to be in error for large perturbations. However, a simple one-energy expression is devised for the shape rather than the magnitude of the reactivity curve, that successfully predicts relative effects. The method is compared with an experimental determination of the reactivity worth of the variable upper reflector of the MITR.

17191 THE REACTIVITY OF NATURAL UO_2 IRRADIAT 6×10^{21} n/cm^2.

S.B.Gunst, E.D.McGarry and J.J.Scoville.

Nuclear Sci. Engng (USA), Vol. 7, No. 5, 407-18 (May, 1960).

Natural uranium dioxide specimens of Shippingport PWR blanket-rod geometry were exposed in the Materials Testing actor (flux 2×10^{14} n cm^{-2} sec^{-1}) and discharged periodically three weeks) for measurements in the Reactivity Measureme Facility (RMF). The time-integrated thermal and epitherma were measured during each exposure cycle, and together wit MTR Daily Power Logs, gave the complete exposure history urements in the RMF were used to determine an experiment for η/η_0 (η_0 is the preirradiation value) which was compared theoretical η/η_0 calculated for the measured exposure histor appropriate neutron-interaction parameters. In the theoreti culations, the thermal absorption cross-section of stable fis products was taken to be 50 barns per fission. Although the mental and theoretical results were derived completely inde agreement within 1% in η/η_0 was found for the behaviour foll all cycles of irradiation comprising exposures from zero to 15 600 MWd/ton.

17192 ON THE VALIDITY OF THE SECOND FUNDAME THEOREM IN A MEDIUM WITH ANISOTROPIC SCATTERING. L.Dresner.

Nuclear Sci. Engng (USA), Vol. 7, No. 5, 419-24 (May, 1960).

The second fundamental theorem of reactor theory state good estimate of the nonleakage probability from a bare reac given by the Fourier transform of the infinite medium kernel ated at the asymptotic buckling of the reactor. Inönü has inv the validity of this theorem for the one-velocity slab reactor isotropic scattering by means of a variational technique. He its use gives very good results even for quite small reactors dimensions of the order of a few mean free paths. In the pre paper the effect of anisotropy in the scattering on the validit theorem is investigated by a variation-iteration technique. I cluded that the theorem is, in general, less reliable the mor tropic the scattering.

17193 A SIMPLIFIED THEORY OF PILE NOISE. C.E.Cohn.

Nuclear Sci. Engng (USA), Vol. 7, No. 5, 472-5 (May, 1960).

A theoretical treatment is given of the statistical fluctua neutron population which occur in nuclear reactors. The abs magnitude and frequency dependence of the spectral density fluctuations is obtained. The model used assumes that the fl tions arise from a "noise-equivalent source" whose strength easily calculated from fundamental considerations. Calculat are also presented of the fundamental statistical errors in c measurements.

17194 FLAT FLUX BY NONUNIFORM MODERATION. J.M.Ravets and J.R.Lamarsh.

Nuclear Sci. Engng (USA), Vol. 7, No. 6, 496-501 (June, 1960

The production of flat thermal flux by the nonuniform di tion of the moderator is discussed within the framework of t group theory for two region reactors. Equations determinin moderator distribution are derived and a numerical solution sented for a typical reactor system. The moderator density found to increase with increasing distance from the centre o core. All combinations of core and reflector materials cann used in these flat flux systems, and the restrictions which de mine allowability are discussed. In the special case of slab actors in which the core and reflector are the same material systems have minimum critical mass.

17195 THE BLACK VOID REACTOR CONCEPT. C.O.Muehlhause.

Nuclear Sci. Engng (USA), Vol. 7, No. 6, 505-7 (June, 1960).

The application of heavily loaded cylindrical fuel elemen two principal reactor configurations is considered. The obje of the work is the design of research reactors suitable for r tion effects studies.

17196 BOUNDEDNESS AND STABILITY IN NONLINEAR REACTOR DYNAMICS. E.P.Gyftopoulos and J.D

Nuclear Sci. Engng (USA), Vol. 7, No. 6, 533-40 (June, 1960).

A novel formulation of the problem of boundedness and s of the power level of a nuclear reactor describable by a nonl model is presented. A sufficient criterion for boundedness a stability is derived and proved to be equivalent to the criter suggested by Welton. The criterion is illustrated by means examples.

97 AN H_2O–D_2O MODERATED REACTOR.
N.P.Klug and P.F.Zweifel.
r Sci. Engng (USA), Vol. 7, No. 6, 541-4 (June, 1960).
alculations are made of the infinite multiplication factor in
l uranium dioxide lattices employing mixtures of light and
water as a moderator. The three parameters varied in the
are (a) the metal-to-water volume ratio, (b) pin diameter,
light-to-heavy water atomic ratio. Maxima in plots of K_∞
hydrogen-to-deuterium ratio indicate that such $H_2O + D_2O$
es would prove advantageous in certain cases. However, in
cases, slight fuel enrichment might be required.

98 BREEDING RATIO IN U^{233} AND Pu^{239} FUELED REACTORS. M.M.Levine.
r Sci. Engng (USA), Vol. 7, No. 6, 545-51 (June, 1960).
reeding ratios for clean near-thermal systems containing
^{233} and moderator have been presented by Chernick and
(Abstr. 757 of 1961). The present work treats Pu^{239} systems
nd extends the results in both systems to take account of the
of the higher isotopes and fission products. The extra
tion by these higher isotopes tends to depress the breeding
but fission in U^{235} or Pu^{241} compensates for this, and the net
is an increase in breeding ratio for plutonium-fuelled
ns.

99 FEW GROUP ANALYSIS OF D_2O–U^{235} ASSEMBLIES.
C.N.Kelber and P.Kier.
r Sci. Engng (USA), Vol. 8, No. 1, 1-11 (July, 1960).
ew-group analysis is applied to a variety of D_2O–U^{235} critical
blies. Use of relatively simple prescriptions for obtaining
constants is sufficient to give good values of the reactivity
wide range of concentrations of U^{235} in D_2O. Among these
prescriptions is one which attempts to take into account
atial variation in the neutron spectrum in reflected systems.
this prescription improves that calculated reactivity by
5% over that obtained with only a single thermal neutron
um characteristic of the core.

00 A NEW METHOD FOR THE SOLUTION OF GROUP DIFFUSION EQUATIONS.
eraro and H.L.Garabedian.
r Sci. Engng (USA), Vol. 8, No. 1, 44-52 (July, 1960).
he diffusion equations associated with the multigroup,
egion problem are solved by expansions in eigenfunctions
are solutions of the Helmholtz equation. A determined
lity equation is exhibited in which the order of the deter-
is independent of the number of groups and which can be
without recourse to complicated computational procedures.
ver, the need to fulfill explicitly the requirements that the
d current associated with each neutron group be continuous
interfaces is eliminated.

01 THE RICE FORMULATION OF PILE NOISE.
E.F.Bennett.
r Sci. Engng (USA), Vol. 8, No. 1, 53-61 (July, 1960).
ectrum and variance of "pile noise" are discussed according
formulation of Rice (Abstr. 1513 of 1946). It is shown that
ce diverges as criticality is approached. A convergent
y closely related to variance is introduced and observations
quantity taken with ZPR-IV', a light water-moderated
enriched source reactor at Argonne.

02 A STUDY OF NONLINEAR REACTOR DYNAMICS.
A.Z.Akcasu and A.Dalfes
r Sci. Engng (USA), Vol. 8, No. 2, 89-94 (Aug., 1960).
he question of nonlinear stability of stationary reactor
s is investigated by two methods. The first method is
c and sets the theory of nonlinear stability on a firm mathe-
l basis. The second method makes use of an electrical
y and is based on the stability criterion stated by Weinberg
gen (Abstr. 10520 of 1954) for nonlinear mechanical systems.
ethods deal with reactor systems in which feedback may be
ear as well as linear. The effect of delayed neutrons is
ed in the treatment. The stability conditions previously
d by others are shown to be special cases of the criteria
ed in this paper.

03 SOME MONTE CARLO AND ANALYTICAL RESULTS FOR RESONANCE CAPTURE IN LATTICES.
enstein.
r Sci. Engng (USA), Vol. 8, No. 2, 122-7 (Aug., 1960).
tailed Monte Carlo studies of the resonance capture in the lowest U^{238} resonances were made for uranium–water lattices and a uranium–graphite lattice. Direct comparison with calculated values is a good test of the validity of the assumptions made in obtaining the theoretical estimates. Good agreement is obtained for the over-all capture in a single resonance and for the energy distribution of absorptions. Monte Carlo tests have also shown that the asymptotic flux is fairly well re-established between the two strongest U^{238} resonances, and that the number of neutrons captured in this energy region is only slightly affected by Doppler broadening and interference between resonance and potential scattering. The calculated resonance escape probability in a uranium–water lattice for 26 resolved resonances is compared with the Monte Carlo value. There is quite close agreement.

17204 A NUMERICAL TECHNIQUE FOR SOLVING GROUP DIFFUSION EQUATIONS. E.L.Wachspress.
Nuclear Sci. Engng (USA), Vol. 8, No. 2, 164-70 (Aug., 1960).
An efficient method for solving group diffusion equations is described. Application of the Perron–Frobenius theory of non-negative matrices allows a direct determination of reactor criticality without calculation of neutron fluxes. Higher flux modes may also be found. Simultaneous calculation of all flux groups simplifies formulation with inelastic- and up-scattering, and also provides a convenient tool for some kinetics studies.

17205 AGE OF U^{233} FISSION NEUTRONS IN WATER.
W.G.Pettus.
Nuclear Sci. Engng (USA), Vol. 8, No. 2, 171 (Aug., 1960).
An experimental measurement shows that the age in water of U^{233} fission neutrons is less than that of U^{235} fission neutrons by $(5 \pm 3)\%$, in agreement with calculations of Faber and Zweifel (Abstr. 15628 of 1960). J.E.Gore

SIMPLE PROCEDURE FOR CALCULATION OF THE FERMI AGE OF LIGHT WATER. See Abstr. 16804

17206 THE DISTRIBUTION OF THERMAL NEUTRONS IN SPACE AND ENERGY IN REACTOR LATTICES.
I. THEORY. H.C.Honeck.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 193-202 (Sept., 1960).
A method is developed for computing thermal neutron distributions in reactor lattices as functions of energy and a single spatial coordinate. The integral form of the transport equation is used and it is assumed that the scattering process is isotropic in the laboratory system. The energy exchange kernels are based on the free gas model of Brown and St. John. The resulting equations are solved by numerical techniques using the IBM 704. The iterative calculations are greatly accelerated by enforcing neutron conservation at each iteration.

17207 THE DISTRIBUTION OF THERMAL NEUTRONS IN SPACE AND ENERGY IN REACTOR LATTICES.
II. COMPARISON OF THEORY AND EXPERIMENT.
H.C.Honeck and I.Kaplan.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 203-9 (Sept., 1960).
The results obtained in Pt I are compared with experimental intracell foil activation measurements. The computed neutron density distributions in D_2O and graphite moderated lattices are in good agreement with the measured distributions. A systematic discrepancy between computed and measured neutron density distributions in water lattices is observed. This discrepancy is probably caused by the inadequacy of the gas model to describe slow neutron scattering from water.

ENERGY DISTRIBUTION OF THERMAL NEUTRONS IN A FINITE SOLID MODERATOR ASSEMBLY. See Abstr. 16794

17208 THE DYNAMICS OF A XENON-CONTROLLED REACTOR.
J.Chernick.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 233-43 (Sept., 1960).
The space-independent dynamics of a reactor controlled by xenon poisoning is investigated. For reactor periods comparable to the delay in xenon production, the reactor is stable. For shorter periods, the reactor is unstable in the neighbourhood of equilibrium unless the prompt xenon yield is a large fraction of the total xenon yield. The reactor power then goes into a stable oscillation. With increase in reactivity, the oscillations are of relaxation type, having the character of a sequence of widely separated power pulses controlled by xenon poisoning. The intensity of the power pulse generally becomes excessive when the reactivity approaches the total controlled by prompt xenon. Xenon burnup is of minor importance over the region controlled by the prompt xenon yield, although

it leads to flux divergence at sufficiently short reactor periods. Analytical methods are developed for treating the dynamics of the system, and the prime importance of nonlinear effects is established. The need for data on the independent yield of both Xe^{135} and its 15 min isomer in fission of major reactor fuels is pointed out.

17209 EFFECT OF DELAYED NEUTRONS ON NONLINEAR REACTOR STABILITY. E.P.Gyftopoulos and J.Devooght.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 244-50 (Sept., 1960).

The effect of delayed neutron precursors on the stability of nuclear reactors described by nonlinear equations is investigated. It is shown by means of Lyapunov's second method that a sufficient condition of stability is that the reactor be stable without delayed neutron precursors. An illustrative example is included.

17210 ON THE APPLICABILITY OF THE TRANSPORT APPROXIMATION TO THE CALCULATION OF REACTIVITY. G.Rakavy.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 251-3 (Sept., 1960).

The validity of the transport approximation is checked for systems which cannot be treated by the diffusion approximation and deviations of the transport approximation from exact calculations are evaluated by means of a perturbation formula. It is concluded that even for critical systems of dimensions of the order of the transport mean free path the transport approximation yields good results.

17211 CONTROL ROD THEORY FOR ASYMMETRICAL ARRAYS AND REFLECTED CORES.
R.L.Murray, W.T.Price and S.H.Birken.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 254-9 (Sept.,1960).

Criticality conditions suitable for hand calculations are derived for reactor control rod configurations of practical interest. Two-group diffusion theory is applied to (a) arrays of several control rods of different materials, sizes, shapes, radial, and angular location; (b) reflected cores containing a symmetric ring of similar rods, with or without an axial rod. The reduction to elementary cases is demonstrated.

17212 THE DANCOFF EFFECT IN H_2O–D_2O MODERATED LATTICES. W.G.Pettus.
Nuclear Sci. Engng (USA), Vol. 8, No. 4, 361-2 (Oct., 1960).

The formulation by Bell (Abstr. 15613 of 1960) of the problem of the mutual shadowing of closely spaced elements in a lattice on the resonance absorption is tested by plotting Bell's Dancoff-factor, defined by

$$\gamma = [S/4\Sigma_m V_m]^{-r}$$

against Σ_m for two different lattices with different combinations of D_2O and H_2O moderator. Very satisfactory agreement with theory is found. J.F.Hill

17213 A FEW-GROUP THEORY OF WATER GAP PEAKING. G.P.Calame.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 400-4 (Nov., 1960).

The conventional calculation of power peaking near water gaps assumes an abrupt change in the neutron spectrum at a gap-core interface. The assumption can be seriously in error, and can result in discrepancies of 50% between calculated and experimental peaking values. In this paper, a position-dependent spectrum is obtained by the use of diffusion theory which, when used in peaking calculations, reduces the discrepancy between theory and experiment to the order of 5-10% or less. Recipes based on the position-dependent spectrum are obtained for the specification of position-dependent cross-sections which may be used in standard diffusion theory codes. The use of these cross-sections in the codes results in an estimate of power peaking factors which represents a considerable improvement over the results given by conventional calculations.

17214 THERMAL NEUTRON FLUX DISTRIBUTIONS IN SPACE AND ENERGY. P.Michael.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 426-31 (Nov., 1960).

The steady-state space–energy distribution of thermal neutrons in homogeneous media is considered in the diffusion approximation. From the general form of the solution it is shown that the asymptotic (in space) distribution depends upon the source distribution and under different circumstances can be qualitatively different. The relation of the asymptotic flux to the usually found infinite medium spectrum is exhibited. For a heavy gas moderator, the asymptotic flux from a source of limited extent is shown to be much softer than an infinite medium spectrum in the same material.

17215 INTEGRAL REACTOR THEORY: ORTHOGONALI IMPORTANCE. M.A.Robkin and M.Clark, Jr.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 437-42 (Nov., 1960).

It is observed that the formal mathematical adjoint of the integral form of the solution of the Boltzmann equation is not same as, and is not a solution for, the formal mathematical a to the integro-differential form. If the concept of importance have a unique physical meaning, there must be a basic physic difference between the adjoint integral and the integral solutic the integro-differential equation. It is shown that such a phys difference can be specified, that the concept of "inverse causa is unecessary, and that normal "forward" causality is sufficie to derive the importance from first principles. The resulting equations for the importance distributions are then shown to b completely consistent with all requirements of orthogonality between these distributions and the neutron distributions.

17216 THE APPLICATION OF STATISTICAL METHODS ANALYSIS FOR PREDICTING BURNOUT HEAT F
R.T.Jacobs and J.A.Merrill.
Nuclear Sci. Engng (USA), Vol. 8, No. 6, 480-96 (Dec., 1960).

The comparative correlations of this report thoroughly demonstrate that significantly more precise equations for cal ing burnout heat flux can be obtained by following the propose "system-describing" concept, that if the independent, system describing variables of a system are known, the burnout heat can be predicted. With this concept, the independent variable inlet temperature has been used rather than the dependent va of outlet subcooling or enthalpy. The same statistical (regre analysis) method of correlation was used for burnout data fro several sources with both inlet temperature and outlet enthal that the consistently better predictions using inlet temperatu would not be attributed to using a different method of correla Due to the fact that reactor technology and design no longer a the engineer safety factor added upon safety factor, a decided advantage of the regression analysis correlation is that it is possible to calculate the statistical uncertainty of the predict burnout heat flux.

17217 PERTURBATION THEORY OF REACTIVITY COEFFICIENTS FOR FAST-NEUTRON CRITICA SYSTEMS. G.E.Hansen and C.Maier.
Nuclear Sci. Engng (USA), Vol. 8, No. 6, 532-42 (Dec., 1960).

The first-order perturbation theory, or equivalently the interpretation of reactivity coefficients, is illustrated for fas neutron critical systems. A second-order perturbation theor small size sample replacements is given and illustrated espe as it pertains to measurements of reactivity coefficients.

17218 LEAKAGE NEUTRON SPECTRUM FROM A BAR CRITICAL ASSEMBLY. L.Stewart.
Nuclear Sci. Engng (USA), Vol. 8, No. 6, 595-7 (Dec., 1960).

Measured with nuclear emulsions as both radiator and de A comparison with similar measurements on the U^{235} analogu this assembly indicates a higher average energy for the Pu^{23} neutrons.

17219 SPECTRAL COMPARISONS WITH HIGH ENERGY ACTIVATION DETECTORS. J.Grundl and A.Usn
Nuclear Sci. Engng (USA), Vol. 8, No. 6, 598-606 (Dec., 1960)

The responses of the activation detectors P(n, p), Al(n, p Fe(n, p), Al(n, α), and Cu(n, 2n) to the neutron spectra at the of the bare U^{235} and Pu^{239} critical assemblies, Godiva and Jez are the basis of a precision comparison of these two spectra 2 MeV. Results, interpreted in terms of the spectral functio $E^{1/2}\exp(-\beta E)$, show that the average energy of this component spectrum in Godiva is 4.7 ± 0.8% lower than in Jezebel. Fro preliminary measurements a close resemblance to the corre fission neutron spectra is indicated in this energy region. Re photoplate measurements in the leakage spectra of both asse are considered and briefly analysed. A discussion and deter of effective thresholds is appended.

17220 COMPUTATIONAL SURVEY OF IDEALIZED FAS BREEDER REACTORS. W.H.Roach.
Nuclear Sci. Engng. (USA), Vol. 8, No. 6, 621-51 (Dec., 1960)

A calculational survey of idealized fast breeder reactors reported. Representative fuel (Pu^{239}, U^{235}, U^{233}), fertile (U^{238} structural (stainless steel), and coolant (sodium) materials a in the calculations, references providing information as to th substitutional effect of other materials. The calculational m defined, input parameters are discussed, and results such as c

critical volume, initial breeding ratios, and spectral indices reactors are tabulated.

21 GENERAL SOLUTION OF THE REACTOR KINETIC EQUATIONS. G.R.Keepin and C.W.Cox.
r Sci. Engng (USA), Vol. 8, No. 6, 670-90 (Dec., 1960).
ıe reactor kinetic equations are reduced to an integral form ient for explicit numerical solution, involving no approxima- eyond the usual space-independent assumption. Numerical tion is performed by the RTS (Reactor Transient Solution) vritten in FORTRAN II for the IBM-704 computer. The teristic roots and residues which arise in this method of n have been computed and are tabulated in detail for each of in fissile species. Analytic or point-function reactivity varia- ay be introduced, together with constant or time-varying rity compensation, and the resulting power response, total release, and compensated reactivity computed precisely as ns of time. The code solves the general non-equilibrium s problem with extraneous sources, the customary equilibrium n being a special case of the general solution. Practical use method is demonstrated through computed response curves presentative reactivity-addition functions in various types of reacting systems.

222 ASSEMBLY OF FISSIONABLE MATERIAL IN THE PRESENCE OF A WEAK NEUTRON SOURCE.
ansen.
ır Sci. Engng (USA), Vol. 8, No. 6, 709-19 (Dec., 1960).
he probability distribution in time at which the neutron tion in a slightly supercritical system attains a prescribed s considered for the case where a source injects well under one n per neutron lifetime. For the case of ramp insertion of vity it is shown that the energy released in the consequent of fissions may in some cases (e.g. unmoderated enriched ım systems) exceed by over a factor of one hundred the r release predicted by the reactor kinetics equations.

223 THE ERROR ESTIMATION OF LINEARIZED NUCLEAR REACTOR EQUATIONS. K.Wajs.
nika (Poland), Vol. 5, No. 11, 737-42 (1960). In Polish.
ıe errors in kinetic equations for a nuclear reactor, treated nearized control system component, are estimated using the of differential inequalities. The influence of delayed neutrons en into account.

24 ITERATION OF MULTIGROUP THEORY AND APPLICATION TO THE CALCULATION OF THE NEUTRON 'RUM IN FLATTENED REACTORS.
tz, K.Ott and S.Sanatani.
nik (Germany), Vol. 3, No. 4, 155-63 (Aug., 1961).
man.
the first part of the paper a homogeneous infinite reactor is ered. An iterative multigroup theory is developed for the ıl and epithermal neutron spectra. In each group interval ectrum is represented by a single-values development n whose floating constants are re-determined at each on. Results agree with the calculated spectra of Hurwitz, Nuclear Sci. Engng (USA), Vol. 1, 280 (1956)]. In the second ıe method is extended to heterogeneous geometry and applied particular case of a finite flattened reactor. J.W.Gardner

225 NUCLEAR BASES FOR THE SITING AND BUILDING OF NUCLEAR REACTORS. G.Blässer and K.Wirtz.
nik (Germany), Vol. 3, No. 4, 164-78 (Aug., 1961).
man.
he concepts of "maximum permissible dose" and "tolerance are introduced and defined with reference to radioactive ıtrations in various parts of the body. Shielding and filtering are then developed and applied to the calculation of local nmental activity levels. Meteorological effects are then uced in relation to reactor siting and numerical examples tual reactors are given. J.W.Gardner

226 A UNIFIED THEORY OF INTERACTION FOR TWO ARBITRARILY MIXED MULTI-GROUP ARRAYS SET LL-DEFINED AND RANDOM REFLECTORS.
ckroyd, E.J.Burton and M.A.Perks.
r Sci. (GB), Vol. 11, No. 2-4, 57-68 (Feb., 1960).
ı interaction theory is given for calculating space arrays of units of arbitrary size, shape and distribution which uses me core and reflector constants as are employed in ordinary reactor calculations for single units. Mixed arrays of fast and thermal units are considered. The reflecting material between units may be well defined or random in distribution. A comparison with experiment suggests that the theory is reasonably accurate and errs on the side of safety. Unlike Monte Carlo methods the method presented requires trivial computation (10 seconds per case computing time on a medium-size computer). Unlike the interaction parameter method it does not require an experiment on a simple assembly of units before a prediction for a complicated array can be made.

17227 FIRST FLIGHT COLLISION PROBABILITY IN LATTICE SYSTEMS. H.Takahashi.
Reactor Sci. (GB), Vol. 12, No. 1-2, 1-15 (May, 1960).

The first flight collision probability in a slab lattice is often used to simplify the calculation of the fast fission factor ϵ and the resonance escape probability p. In this paper, lattice cells of cylindrical rods, which may be arranged in triangular, square or hexagonal lattice form, are approximated by an equivalent circular cylindrical cell, and the first flight collision probability of such a cell is discussed by three methods. The first is a method due to Weinberg, the second is a modified spherical harmonics p_N approximation, and the third is an exact method for this lattice cell. The first flight collision probability in a particular rod lattice is calculated by both the equivalent slab and circular lattice approximations, and the numerical results are compared.

17228 HEAT TRANSFER FROM HEATED BODIES TO LIQUIDS WITH VAPORIZATION, WITH REFERENCE TO FLOW CONDITIONS. H.Bühler and F.J.Schmidt.
Atomkernenergie (Germany), Vol. 5, No. 1, 18-22 (Jan., 1960). In German.

The practical test conditions for determining the coefficient of heat transfer, and the theoretical basis of heat transfer determinations, with vaporization cooling in the conventional cooling liquids are given. The effect of the flow velocity of the cooling liquid, the surface finish of the heated body, additions to the cooling liquid and the temperature of the cooling medium are discussed. The reactions occurring during the boiling and the film forming phases, and during transition between them, are described. Vaporization cooling processes are very important for understanding the heat transfer conditions with jet units and in particular with boiling water reactors, steam generators and the heat exchangers of other types of nuclear reactors, since the thermodynamic efficiency can be noticeably improved by advantageous heat rejection.

17229 THE DETERMINATION OF "HOT-CHANNEL FACTORS [KÜHLKANALFAKTOREN]" IN NUCLEAR REACTOR FUEL-ELEMENTS. J.Clauss.
Atomkernenergie (Germany), Vol. 5, No. 2, 41-52 (Feb., 1960).

Intended to contribute to a field covered rather sparsely in the literature, namely "hot-channel factors". These are additional factors to compensate for thermal uncertainties in the design of an atomic reactor due to physical and technical details, such as the distribution of the neutron flux, its local deviations which cannot be calculated exactly in advance, tolerances in the dimensions of the core subassemblies, particular qualities of the material which are not known exactly, the distribution of the cooling agent on the various cooling channels, and other factors. The physical proportions of the hot-channel factors are not gone into. They vary considerably from one reactor type to the next, and can be determined quite accurately in individual cases, especially be experiment. The technical factors, too, depend on the reactor type — or more accurately — on the type of fuel element and cooling channel. Almost all fuel elements, however, can be traced back to the geometry of the plate or the cylinder, so that the technical factors can be calculated in a relatively simple way. If the physical factors are then known, there are two methods for calculating the temperature at the hot spot, the product method and the statistical method. The sum of the individual deviations resulting from the last-mentioned method for calculation gives a third possible value of maximum temperature on a certain spot of the hot channel.

17230 STATIC HYDRAULIC STABILITY OF BOILING WATER REACTORS. H.Kornbichler.
Atomkernenergie (Germany), Vol. 5, No. 11, 397-400 (Nov., 1960). In German.

Under unfavourable conditions, a flow of subcooled water brought up to boiling in a heated channel can have a pressure drop characteristic which, instead of increasing monotonically, rises to a maximum and then declines. Operation of the channel in the neighbourhood of such a maximum will give rise to static instabi-

lities, since different flow rates can produce the same pressure drop. This fact is well known from forced circulation boilers. It is demonstrated in a general way that these static instabilities can never occur in a boiling water reactor.

17231 HIGH POWER HEATING OF A CYLINDRICAL TUBE BY ELECTRON BOMBARDMENT OF THE INSIDE SURFACE. R.E.Haigh and P.H.Dawson.
Brit. J. appl. Phys., Vol. 12, No. 11, 609-13 (Nov., 1961).

Presented at the Symposium on the Design of Experimental Equipment for use in Nuclear Energy Research, 11th-14th April, 1961, at Atomic Energy Research Establishment, Harwell. The paper deals with the simulation of the high heat rating of power reactor fuel elements in "out of pile" tests. The method of heating chosen for a particular rig will depend on the exact nature of the tests for which the rig is designed, and this may make conventional heaters unsuitable. Very high heat fluxes can be obtained by electron bombardment and this method was used in rig tests on a Calder Hall type element. The test element was essentially a coaxial diode; a vacuum tube representing the fuel rod was the anode, the cathode being a tungsten wire stretched down the centre. Maximum reactor heat ratings were achieved easily and it is considered that if required the power input could have been several times greater. The paper discusses the characteristics of the method and describes the important features of the design.

17232 GASEOUS SUSPENSIONS — A NEW REACTOR COOLANT. D.C.Schluderberg, R.L.Whitelaw and R.W.Carlson.
Nucleonics (USA), Vol. 19, No. 8, 67, 68, 70, 72, 74, 76 (Aug., 1961).

Heat transfer and pressure drop characteristics of suspensions of 1-5 μ graphite particles in N_2, He and CF_4 at densities up to 8 lb/ft^3 were investigated and empirical correlations found. The test loops were almost entirely free from troubles due to erosion, plugging or surface adhesion. Gas-suspension coolants have a higher heat transport and heat transfer than pure gases and, if suitable pumps can be developed, may become useful coolants for nuclear reactors. R.D.Smith

17233 AN INVESTIGATION OF EFFECTIVE NEUTRON TEMPERATURES.
W.P.Stinson, L.C.Schmid and R.E.Heineman.
Nuclear Sci. Engng (USA), Vol. 7, No. 5, 435-41 (May, 1960).

Information about effective neutron temperatures has been inferred from measurements of the ratio of the thermal-fission activity of a Pu^{239} foil to that of a U^{235} foil. A discussion of the ratios obtained in various assemblies which were placed in the centre of a graphite thermal column is presented. The assemblies were made of natural uranium, lead, or graphite. In some cases the assemblies were surrounded by a layer of water. The experiments were conducted at thermal-column temperatures which ranged from 18 to 640°C. The data obtained in the case of the graphite assembly are used as a calibration of the neutron temperature. To within the accuracy of the experiment, the shape of this calibration curve is the same as the shape obtained from the data of Westcott. The results, for all other cases, indicate for the range of temperatures investigated that the ratio of the thermal-column temperature to the effective neutron temperature in an assembly varies linearly with the temperature of the thermal column.

17234 TECHNIQUES FOR THE IRRADIATION OF CERAMIC FUELS IN A MODERATE THERMAL NEUTRON FLUX. W.G.Blessing.
Nuclear Sci. Engng (USA), Vol. 8, No. 2, 105-11 (Aug., 1960).

Considers the physics calculations required to determine power, heat flux, and burnup for ceramic fuel materials as a function of variables such as fuel radius, enrichment, reactor thermal neutron flux, and irradiation time. It is demonstrated that high fuel burnups may be obtained using moderate thermal neutron flux by proper choice of variables. Heat transfer calculations utilizing the thermal resistance concept for a specific capsule design are described, together with an analysis of the design and operational uncertainties.

17235 CRITICAL MEASUREMENTS ON NEAR-HOMOGENEOUS BeO-MODERATED, ENRICHED-URANIUM FUELED SYSTEMS.
F.A.Kloverstrom, R.M.R.Deck and A.J.Reyenga.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 221-5 (Sept., 1960).

A series of critical measurements on unreflected systems, fueled by thin enriched uranium (93.2%) foils, is described. Fuel density is varied by use of different foil thicknesses and spacings between foils. Five fuel densities have been used which correspond to atomic BeO/U^{235} ratios from 246 to 7660. For three of ratios, the fuel foil thickness was varied to find effects of self-shielding and flux depression on the critical dimensions.

17236 CRITICALITY CALCULATIONS OF BeO-MODERATED ENRICHED URANIUM SYSTEMS. R.E.Lingenfelter
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 226-32 (Sept., 1960).

Criticality calculations have been performed on a series of unreflected BeO—U assemblies made at the Lawrence Radiation Laboratory. The calculations were done with the one-dimensional multigroup diffusion code ZOOM. In addition to determining the general reliability of the code input constants, studies were made U-foil self-shielding corrections and the Be(n, 2n) reaction.

17237 THERMAL NEUTRON FLUX DISTRIBUTIONS IN METAL-HYDROGENOUS SHIELDS.
D.C.Anderson and K.Shure.
Nuclear Sci. Engng (USA), Vol. 8, No. 3, 260-9 (Sept., 1960).

A calculational technique is presented for predicting thermal neutron fluxes in the primary shields of reactor systems which eliminates reliance on mock-up experimental data. A multigroup P_1 approach is employed with the spatial dependence of the neutron attenuation adjusted through use of a point source attenuation kernal for a homogeneous hydrogenous medium. Comparison of calculation with experiment is presented.

17238 PHOTONEUTRONS AND THE CONTROL OF A POOL TYPE REACTOR. A.L.Colomb.
Nuclear Sci. Engng (USA), Vol. 8, No. 4, 289-93 (Oct., 1960).

In a pool type reactor installation, the fission chambers or ionization chambers controlling the reactor detect two types of neutrons, viz. thermalized fission neutrons and photoneutrons produced around the detector in a D(γ, n) H reaction. If the photoneutrons are produced by fission product gamma rays, there will be superimposed neutron flux that may lead to unsafe operating conditions. This effect has been analytically and experimentally studied, and it is shown here that the unsafe conditions can be suppressed either by placing the detector closer to the reactor or by limiting rate of change of reactor flux to a safe value.

17239 NEUTRON RETHERMALIZATION CROSS SECTION MEASUREMENTS IN GRAPHITE.
R.A.Bennett and R.E.Heineman.
Nuclear Sci. Engng (USA), Vol. 8, No. 4, 294-9 (Oct., 1960).

The thermal neutron absorption rate in "1/v" materials has been observed near a discontinuity in the temperature of a graphite moderator. A plausible group diffusion model of the space and energy distributions of the thermal neutrons has been assumed, experimental data have been used to obtain the transfer cross sections, called rethermalization cross-sections, to be used with this model. The cross-sections obtained for crystalline graphite are small compared to those expected for gaseous graphite; but increase by a factor of about seven, from $(1.9 \pm 0.05) \times 10^{-3}$ to $(14.5 \pm 2.6) \times 10^{-3}$ cm^{-1}, from the lowest temperature of 108°K the highest temperature of 666°K.

17240 GENERALIZED RESONANCE INTEGRAL REPRESENTATION [FOR ABSORPTION]. M.M.Levine.
Nuclear Sci Engng (USA), Vol. 8, No. 4, 363-4 (Oct., 1960).

From a consideration of the Narrow Resonance and Narrow Resonance Infinite Absorber Approximations of Chernick and V [Nuclear Sci. Engng, Vol. 4, 649 (1958)] and Dresner (1957) it is argued that for Th^{232} and U^{238} the effective resonance integral f cases — homogeneous mixtures, single lumps and lattices of c carbide, etc. — can be represented, for each species of absorb by a single relationship of the form.

$$R = f(\sigma^P + S^{eff}/4NV)$$

where σ^P is the potential scattering per absorber atom, S^{eff} th Dancoff correction, N the number density of atoms and V the volume. This assumption is tested by plotting R against $[\sigma^P + S^{eff}/4NV]^{1/2}$ for U^{236} and Th^{232} and shows a satisfactory j fication of the assumption. J.J

17241 PROMPT CRITICAL ASSEMBLY GAMMA RAY SOURCES. C.S.Shapiro.
Nulcear Sci. Engng (USA), Vol. 8, No. 6, 515-17 (Dec., 1960).

The method of obtaining the gamma dose rate during a pro critical burst from the "Godiva" reactor (Los Alamos) is pres In this measurement, the fission product gamma ray contributi to the total gamma ray dose must be determined. The determi

s quantity is described along with the results. Conclusions awn as to the relative contributions to the total dose from), capture, and inelastic collision gamma-ray sources.

242 NEGATIVE-REACTIVITY MEASUREMENTS. W.S.Hogan.
ar Sci. Engng (USA), Vol. 8, No. 6, 518-22 (Dec., 1960).
legative-reactivity measurements are frequently made by the rop and source-jerk techniques. Analysis of the data from experiments by the usual methods requires measurement of ux-time curve during a transient. Two alternative methods of ing negative reactivities are presented here. Neither of methods requires measurement of a flux transient. Experi- l results using these methods are given.

243 THE AUTOMATIC POWER LEVEL VARIATION AND THE AUTOMATIC COMPENSATION OF THE REACT- CHANGES IN THE WWR-S REACTOR. P.Shul'tz [P.Szulc]. onika (Poland), Vol. 5, No. 9, 503-12 (1960). In Russian.

244 CHEMICAL REACTION AND DIFFUSION IN A CATALYTIC TUBULAR REACTOR. R.E.Walker.
of Fluids (USA), Vol. 4, No. 10, 1211-16 (Oct., 1961).
The general solution to the axially symmetric problem of sion, reaction, and convection of a trace reactant in a catalytic ar flow reactor is presented. First-order heterogeneous and geneous reaction kinetics are assumed as well as a non- erating Poiseuille flow. The decay of reactant upstream and stream of the source is examined. Machine calculations have used to study in detail the characteristics of the asymptotic ion which is shown to be similar to the solution for the one- nsional model frequently used in analysis of experimental or data. This study has resulted in a guide that can be used dging the error introduced through using a one-dimensional pretation of a practical system. In addition, it is further point- t that, for those conditions where the reaction is controlled by convection and diffusion, flow reactor techniques can be used easure the diffusion coefficients of labile chemical species.

245 ORGANIC COMPOUNDS AS MODERATORS IN NUCLEAR REACTORS.
Dubovskii and M.N.Lantsov.
naya Energiya (USSR), Vol. 6, 563 (1959). In Russian.
sh translation in: Reactor Sci. Technol. (GB), Vol. 12, No. 3, 3 (June, 1960).
In a small liquid-moderated, enriched uranium assembly, cality was reached by raising the level of the organic moderator. a variety of moderators, the critical mass, the rate of increase activity with rising moderator level for the supercritical tor, and the thermal neutron Laplacian were determined. Its showed that no substantial increase in critical volume lted from substitution of organic liquids for water moderator, ate of increase of neutron age in organic liquids was smaller the rate of decrease of hydrogen nuclei, and, for equal hydrogen i concentration, the neutron age in organic liquids was much r than in water. J.E.Gore

SCATTERING SHIELDS FOR NUCLEAR SPACE POWER. Abstr. 15582

17246 METHOD OF MEASURING THE GROWTH OF A CONTROL SPECIMEN OF GRAPHITE AFTER IRRADIATION. P.A.E.Crosse and W.L.Snowsill.
Brit. J. appl. Phys., Vol. 12, No. 11, 637-9 (Nov., 1961).
A method is described for accurate measurement of the length of a control specimen of graphite independent of the condition of its surface. A specially shaped groove is turned near each end of the 10 cm long × 1·25 cm diameter specimen, and is filled with flame-sprayed Magnox. A technique is described for producing a high-quality surface on the Magnox on which a diamond indentation appears under microscopic examination as a pair of cross wires. Using the "cross wires" as datum marks, and a high-quality travelling microscope, measurements to an accuracy of 1 in 25 000 are readily attainable. Methods are discussed for increasing this to a possible 1: 100 000.

17247 THE MEASUREMENT OF REACTIVITY. C.A.Sastre.
Nuclear Sci. Engng (USA), Vol. 8, No. 5, 443-7 (Nov., 1960).
The use of a general purpose analogue computer for the continuous measurement of reactivity of a nuclear reactor is described. The machine is programmed to solve the conventional space-independent reactor kinetics for reactivity using the signal from an ion chamber as input data. This technique provides reactivity information instantaneously and continuously. Using it, one can calibrate control rods "on the run", and can measure stationary values of reactivity without waiting for asymptotic periods to develop.

DEFINITION AND CALCULATION METHODS OF THE AMPLIFICATION FACTOR OF NEUTRON AMPLIFIERS. See Abstr. 16792

THE CHARACTERISTICS OF HOMOGENEOUS NEUTRON AMPLIFIERS. See Abstr. 16793

17248 γ—γ COINCIDENCE METHOD FOR MEASURING RESONANCE ESCAPE PROBABILITY IN U^{238} LATTICES. R.Sher.
Nuclear Sci. Engng (USA), Vol. 7, No. 5, 479-80 (May, 1960).
To detect the neutron activation of U^{238} foils used in resonance escape probability measurements, coincidence counting of the 285 and 106 keV γ-rays from the Np^{239} decay was used. The results are in good agreement with those of the β^--counting of chemically separated U^{239}, and have the advantage that no chemistry or destruction of foils is involved, and there is no interference from extraneous activities; the disadvantages are that longer counting times and more elaborate counting equipment may be required. J.E.Gore

17249 SOME NOTES ON THERMONUCLEAR REACTORS. G.Martelli.
Nuovo Cimento Suppl. (Italy), Vol. 19, No. 1, 67-82 (1961).
This article is based on a series of lectures for postgraduate students in the University of Birmingham, and assumes a knowledge of the elementary principles of plasma physics. It is aimed to give both a description of the present achievements in this field and some critical discussion of the principles involved in the various types of machines. Constructional details of the devices mentioned in the article can be found in the references.

ATOMIC AND MOLECULAR PHYSICS

17250 THE TREATMENT OF MANY-PARTICLE PROBLEMS IN QUANTUM CHEMISTRY BY MEANS OF THE GAUSS INTEGRAL TRANSFORM. L.Hofacker and H.Preuss.
Z. Naturforsch. (Germany), Vol. 16a, No. 5, 513-19 (May, 1961). In German.

A survey of the method of simplifying the solution of Schrödinger's equation for many-particle systems by the use of integral transforms. The Gauss transform is introduced and an outline given of its properties and application to the case of Hamiltonians containing an arbitrary number of electrons and nuclei. Applications in quantum chemistry are discussed.

R.G.C.Arridge

ATOMS

SCHRÖDINGER'S EQUATION FOR THE HELIUM ATOM: LOWER BOUNDS FOR EIGENVALUES. See Abstr. 15686

17251 JUSTIFICATION OF THE RULE OF SUCCESSIVE FILLING UP OF (n + l)-GROUPS. V.M.Klechkovskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 465-6 (Aug., 1961). In Russian.

It is demonstrated that the rule (previously formulated on the basis of a generalization of the experimental data) that filling of atomic electron levels proceeds (with growth of atomic number) in accordance with a sequence which corresponds to increasing values of the sum of the principal and orbital quantum numbers, can be deduced theoretically from the Thomas–Fermi statistical model. A comparison is made of two independently derived descriptions of the interval within which the level set with a given value of the sum n + l is filled up. [English translation in: Soviet Physics–JETP (USA)].

17252 THE MATRIX ELEMENTS FOR THE ELECTRON CONFIGURATION f^4. I. THE COEFFICIENTS OF FRACTIONAL PARENTAGE AND THE MATRIX ELEMENTS FOR SPIN COUPLING. S.Hüfner.
Z. Phys. (Germany), Vol. 164, No. 3, 257-68 (1961). In German.

Using the tensor operational method developed by Racah, the coefficients of fractional parentage and the matrix elements for spin coupling are calculated and tabulated numerically for the electron configuration f^4.

J.K.Skwirzynski

17253 THE MATRIX ELEMENTS FOR THE ELECTRON CONFIGURATION f^4. II. THE ENERGY LEVELS FOR Ho^{3+} ION. S.Hüfner.
Z. Phys. (Germany), Vol. 164, No. 3, 269-73 (1961). In German.

The energy levels of Ho^{3+} ion are calculated by diagonalization of complete matrices of Coulomb and spin exchange forces for the electron configuration $f^{10} \cong f^{-4}$. The J-values and the energy levels are in good agreement with experimental data.

J.K.Skwirzynski

17254 SPIN-ORBIT COUPLING IN THE FIRST AND SECOND TRANSITION SERIES. T.M.Dunn.
Trans Faraday Soc. (GB), Vol. 57, Pt 9, 1441-4 (Sept., 1961).

A complete list of one electron spin-orbit coupling parameters ζ_{nd} is compiled for the configurations d^x, $d^{x-1}s$ and $d^{x-2}s^2$ of the first two transition series up to the oxidation state M(VI). These parameters have been obtained from spectral data where available and otherwise by the use of extrapolation methods.

17255 ANGULAR MOMENTUM DISTRIBUTION IN THE STATISTICAL ATOM WITH A NET ANGULAR MOMENTUM. V.S.Mathur.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 3, 305-10 (May 26, 1960).

Following the justification of Theis [Z. Phys. (Germany), Vol. 140, 1 (1955)] for using Fermi's method of angular momentum assignment, the author has calculated the number of s-, p-, d- and f-electrons (as functions of the atomic number Z) in a statistical atom with a net angular momentum, J. The tables of statistical electron distribution due to Thomas (1954) are used. For L = 0, the curves obtained are in much better agreement with the empirical ones than the corresponding curves due to Oliphant (1956). The effect of taking account of the conservation of angular momentum in the atom, on the angular momentum distribution, turns out to be small. However, it serves to bring the theoretical p- and d-electron curves to somewhat closer agreement with the empirical ones.

17256 ON THE EVALUATION OF INTEGRALS OCCURRING IN THE THEORY OF THE CORRELATED ELECTRONIC WAVE FUNCTIONS. L.Szász.
J. chem. Phys. (USA), Vol. 35, No. 3, 1072-6 (Sept., 1961).

It can be shown that the simplest generalization of the Hylleraas method for atoms with arbitrary number of electrons leads to integrals of six and nine dimensions, respectively, where the inter-electronic distances occur in the integrands. The purpose of the present paper is to show that the nine-dimensional integrals can be treated by a similar procedure to that which was suggested for the evaluation of the six-dimensional integrals by Hylleraas and Bre

17257 THE LIFETIME OF THE 6^3P_1 TERM IN THE BARIUM SPECTRUM. H.Bucka and H.H.Nagel.
Ann. Phys. (Germany), Vol. 8, No. 5-6, 329-32 (1961). In Germa

The lifetime was determined by the double resonance method from the line-width of the transitions between Zeeman levels of the 6^3P_1 term for even barium isotopes. Its value, $(1.21 \pm 0.12).10^{-7}$ is only two-fifths that derived from the oscillator strength of the intercombination line $6^1S_0 \rightarrow 6^3P_1$, considering only decay to the ground state (Abstr. 4901 of 1961). The lifetime is thus determined to a considerable extent by transitions allowed to two ^3D terms.

J.Sher

17258 POTENTIAL FUNCTION OF HELIUM-LIKE ATOMS AND ELECTRON SCATTERING BY THE BORN APPROXIMATION. S.C.Mukherjee.
Indian J. Phys., Vol. 35, No. 7, 333-40 (July, 1961).

The potential function of helium-like atoms is derived by using the wave-function of Hartree and Ingman (1933), and the scattering cross-section of electrons by the helium-like atoms is calculated by the method of the Born approximation. The theoretical result at low angular range are found to be in excellent agreement with the experimental findings of Hughes, McMillen and Webb (1932).

17259 HYPERFINE STRUCTURE IN THE $^3P_1$ LEVEL OF TWENTY-FOUR HOUR ISOMER OF MERCURY 197. H.R.Hirsch.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1192-1202 (Nov., 1961).

The hyperfine structure of Hg^{197*} was measured with greater accuracy than had been obtained in conventional spectroscopic work. The nuclear magnetic dipole and electric quadrupole interaction constants, A and B, were calculated: A = –2328.8 ± 1.7 Mc/s; B = – 901 ± 13 Mc/s. The isotope shift is 2240 ± 130 Mc/s relative to Hg^{198}. An electronic g value of 1.4861 ± 0.00036 was found for the $^3P_1$ level. The data were gathered with the use of level-crossing, double-resonance, and magnetic scanning techniques. The relatively new level-crossing experiment was applied to Hg^{199} and Hg^{197}. The measurements lead to values of the nuclear moments and estimates of the nuclear charge distribution, and they pave the way for more accurate experiments that will yield data on the distribution of the nuclear magnetization.

17260 STUDY BY ELECTRON BOMBARDMENT OF THE LIFETIME AND HYPERFINE STRUCTURE OF THE LEVELS OF SODIUM AND CAESIUM. Y.Archambault, J.P.Descoubes, M.Priou, A.Omont and J.C.Pébay-Peyroula.
J. Phys. Radium (France), Vol. 21, No. 8-9, 677-8 (Aug.-Sept., 1
In French.

Gives results of experiments on the Zeeman sub-levels of $^2D_{5/2}$ and $^2D_{3/2}$ levels in Na and Cs by the methods of Abstr. 2055 of 1960. Also describes technique of attempts made to obtain more precise results on the shapes of the resonance lines by sweeping the frequency instead of the magnetic field. The precision hoped was not observed.

J.Haw

17261 HYPERFINE-STRUCTURE SEPARATIONS, ISOTOPE SHIFTS, AND NUCLEAR MAGNETIC MOMENTS OF THE RADIOACTIVE ISOTOPES Tl^{199}, Tl^{200}, Tl^{201}, Tl^{202}, AND Tl^{2}. R.J.Hull and H.H.Stroke.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1203-12 (Nov., 1961).

The hyperfine structure and isotope shift of five radioactive

opes of thallium were measured spectroscopically. Tl^{199} (7.4 hr) Tl^{200} (27 hr) were produced by alpha bombardment of gold; Tl^{202} (3 day), Tl^{202} (12 day), and Tl^{204} (4 year) were produced by eron bombardment of liquid mercury. The isotopes were ted in electrodeless-discharge lamps. Approximately 0.001 μg idio-thallium was used in the lamps. The h.f.s. splittings and ope shifts in the $6^2P_{1/2}$, $6^2P_{3/2}$, and $7^2S_{1/2}$ states were obtained by g a 10 in. plane diffraction grating in autocollimation in a 40 ft or monochromator. Previously measured values of the nuclear s of the odd—even isotopes were verified. Nuclear magnetic ents or upper limits on the moments were calculated by parison of the hyperfine splittings of the radioactive isotopes the known splittings and moments of the stable thallium opes. A definite dependence of the relative isotope shifts on ron number was observed.

17262 TIME RESOLVED EMISSION OF LINES FROM SEVERAL IONS PRODUCED BY A CONDENSED UUM SPARK. J.L.Schwob and G.Balloffet.
hys. Radium (France), Vol. 22, No. 6, 389-91 (June, 1961).
rench.

Lines from ions excited to states of energy between 20 and eV were detected by a phosphor—photomultiplier combination. capacitors had values of 2 to 8 μF (fringing frequencies to 65 kc/s). A discussion is given of the possible mechanisms lved, since one feature shown by the oscillograms is a peak in radiation from O VI (1031 A) when there is nothing from O V 1 A). G.H.C.Freeman

17263 ON THE PROBLEM OF NARROWING HYPERFINE LINES IN THE VAPOURS OF ALKALI ELEMENTS. Yué-chzhu [Wang Yüeh-chu].
iotekhnika i Elektronika (USSR), Vol. 5, No. 5, 834-9 (May, 1960).
Russian.

Doppler broadening of hyperfine spectral lines of the fundaital state alkali atoms is decreased in a system composed of t gases and vapours of alkali elements. The effect is due to diffusion of atoms of alkali elements in an inert gas. When isions between alkali atoms are neglected, a relatively simple istical analysis gives the dependence of the line width on the sion velocity or on the time of the velocity correlation of the ns investigated. Theoretical results are compared with experiital data J.M.Silberstein

17264 INTENSITY RATIOS IN DOUBLETS OF THE FINE STRUCTURE IN THE Al III SPECTRUM.
isiel and H.Niewodniczański.
a. phys. Polon. (Poland), Vol. 20, No. 8, 633-46 (1961).

The intensity ratios were measured for spectral lines in the doublets of the fine structure of Al III: $3p^2P^0_{1/2,3/2}—3s^2S_{1/2}$ of elength 1862.75 A and 1854.71 A as well as those of greater elength $4p^2P^0_{1/2,3/2}—4s^2S_{1/2}$ (5722.75 A, 5695.47 A), $_{3/2}—4p^2P^0_{1/2,3/2}$ (3702.09 A, 3713.10 A) and $4p^2P^0_{1/2,3/2}—3d^2D_{3/2,5/2}$ 01.92 A, 3601.62 A, 3612.35 A). In the case of the doublet $P^0_{1/2,3/2}—3s^2S_{1/2}$, a considerable divergence from the intensity o of 100 : (94 ± 8) was found instead of the predicted 100 : 50. results for the remaining doublets are in satisfactory agreeit with the sum rules.

17265 PRESSURE BROADENING AND SHIFTING OF IRON LINES BY ARGON ATOMS. P.Hey.
strophys. (Germany), Vol. 52, No. 4, 254-65 (1961). In German.

The absorption spectrum of Fe 1, in the presence of Argon, studied with a King's furnace. The broadening and shifting of lines is related to the Van der Waals forces. Effective ss-sections and interaction constants are given. Agreement a simplified theoretical picture is satisfactory. T.Erber

17266 THE THIRD SPECTRUM OF GOLD (Au III). L.Iglesias.
ds. Nat. Bur. Stand. (USA), Vol. 64A, No. 6, 481-5 (Nov.-Dec., 1960).

The spark spectrum of gold was photographed in a helium atsphere from 500 to 6600 A. About 500 lines have been assigned he third spectrum, Au III, and separated from those belonging to erent stages of ionization, by observation of the polarity of the s. Sixty-two levels were found: 17 even levels, arising from the and $5d^96s$ configurations; and 45 odd levels, belonging to the 6p and $5d^96s6p$ configurations. All of the expected levels from the figurations $5d^9$, $5d^96s$ and $5d^96p$ have been identified except for very high terms bases on the $5d^9(^1S)$ core of Au IV. With these els it was possible to classify 256 lines.

17267 THE RATIOS OF THE TRIPLET COMPONENT INTENSITIES OF $(1s2p\ ^3P^0_{2,1,0}—1s4s\ ^3S_1)$ λ 4713 A AND $(1s2p\ ^3P^0_{2,1,0}—1s4d\ ^3D_{3,2,1})$ λ 4472 A OF HELIUM, UNDER DIFFERENT SPECTRAL EXCITATION CONDITIONS. M.D.Kunisz and J.Séguier.
J. Phys. Radium (France), Vol. 21, No. 6, 527-31 (June, 1960).
In French.

To verify the sum rule for the triplets, the ratios of the intensities were measured, both taking reabsorption into account, and under such conditions that the reabsorption could be neglected. The measured ratios of the sum of the intensities of the two near components of the 4713 and 4472 lines to that of the remote component are respectively: 7.5 ± 0.1 and 7.7 ± 0.1, instead of 8, the theoretical value.

17268 THE SPECTRUM OF SINGLY IONIZED ATOMIC IODINE (I II). W.C.Martin and C.H.Corliss.
J. Res. Nat. Bur. Stand. (USA), Vol. 64A, No. 6, 443-79 (Nov.-Dec., 1960).

The I II spectrum was excited in electrodeless lamps and photographed from 655 to 11084 A. Wavelengths and estimated intensities are given for almost 2 400 lines. A revision and extension of the earlier analyses of this spectrum has increased the number of known even levels from 43 to 124, and the number of odd levels from 55 to 190. New gj-factors are given for 46 levels, and the previous designations of 40 levels are changed. Improved measurements in the vacuum ultraviolet region give a correction of 7.4 cm^{-1} to be subtracted from the values listed in Atomic Energy Levels, Vol. 3 (1958), for all levels above the ground configuration. The approximately 1 800 classified lines now include all of the strongest lines. The $^1S_0$ of the ground configuration $5s^25p^4$ was found, and this configuration has been fitted to intermediate coupling theory. Magnetic dipole transitions between levels of the ground configuration, $^3P_2—^1D_2$ (7282 A) and $^3P_1—^1S_0$ (4460 A), were observed and their nature confirmed by the Zeeman effect. The line $5p^4\,^3P_2—^1D_2$ shows hyperfine structure which is in approximate agreement with a theoretical calculation of the expected structure. New levels were found for almost all higher configurations. All previously known series have been extended and new ones found. From one of the new series, $5p^5(^4S^0)5—12g^4G^0_{9/2}$, the principal ionization energy for I II (154304 ± 1 cm^{-1}) was derived. The results of the analysis are compared with theoretical expectations in a number of cases.

DETERMINATION OF THE WAVELENGTH OF THE $2p_{10}$-$5d_5$ LINE OF Kr^{86} FOR NON-PERTURBED ATOMS. See Abstr. 16085

Kr^{86} SPECTRAL LINE SHIFT ALONG THE LENGTH OF A D.C. CAPILLARY DISCHARGE. See Abstr. 16279

17269 THE ABSORPTION SPECTRA OF MAGNESIUM AND MANGANESE ATOMS IN SOLID RARE GAS MATRICES. O.Schnepp.
J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 188-95 (Jan., 1961).

Experiments were made at liquid helium temperature. An absorption system of magnesium near 2850 A and two for manganese near 4000 and 2800 A were observed. These absorptions lie very close to the wavelengths of allowed atomic transitions and it is concluded on the basis of the evidence presented that the absorbing species are atoms which are, in general, trapped at more than one type of site. The crystal field causes the removal of the orbital degeneracy of the excited atomic P states; the splitting energy is observed to be of the order of 300 cm^{-1}. It is proposed that the removal of the degeneracy is due to asymmetric environments of the trapping site. Possible sites are discussed.

17270 ANALYTICAL FORMULA FOR CONTINUOUS ABSORPTION COEFFICIENT OF THE HYDROGEN NEGATIVE ION. T.Tietz.
Phys. Rev. (USA), Vol. 124, No. 2, 493-5 (Oct. 15, 1961).

The approximate formula derived gives results comparable to those obtained by Chandrasekhar, who used an eleven-parameter ground-state function and the dipole velocity matrix element. The present numerical results are compared with the corresponding numerical calculations of Geltman (Abstr. 1417 of 1957).

17271 MEASUREMENT OF THE OSCILLATOR STRENGTHS OF THE GALLIUM LINES 4033 A AND 4172 A AND THE IRON LINE 3720 A. C.Ottinger and K.Ziock.
Z.Naturforsch. (Germany), Vol. 16a, No. 7, 720 (July, 1961).
In German.

Apparatus previously described (Abstr. 6983 of 1957) has been improved and used to measure the oscillator strengths of these lines in terms of the lifetimes of the excited states; values are respectively 0.089, 0.087 and 0.635. G.F.Lothian

17272 DETERMINATION OF OSCILLATOR STRENGTHS THROUGH LIFETIME MEASUREMENTS OF THE FIRST EXCITED LEVELS FOR THE ELEMENTS Ga, Al, Tl, Mg, and Na.
B.Brehm, W.Demtröder and O.Osberghaus.
Z. Naturforsch.(Germany), Vol. 16a, No. 8, 843 (Aug., 1961).
In German.

In the vapours of the elements studied, optical excitation radiation modulated at 18 Mc/s by ultrasonic techniques was used to produce resonance radiation modulated at the same frequency. Measurement of the modulation phase shift between the excitation radiation and the resonance radiation provided a direct measure of the lifetimes of the excited states. These lifetime measurements were used to calculate transition probabilities and oscillator strengths. Also, for sodium vapour, the effect of the presence of a foreign gas on the lifetime was investigated. P.M.Parker

17273 EXTENSION OF SERIES IN THE FIRST SPECTRUM OF INDIUM (In I). W.R.S.Garton and K.Codling.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 600-6 (Oct., 1961).

The ultraviolet absorption spectrum of indium vapour was photographed by means of a 3-metre grating spectrograph. Lines of the series $5^2P_{1/2}{}^0-n^2S_{1/2}$ (n = 9 to 27), $n^2D_{3/2}$ (n = 7 to 33), $5^2P_{3/2}{}^0-n^2S_{1/2}$ (n = 10 to 29), $n^2D_{3/2}$ (n = 8 to 19), $n^2D_{5/2}$ (n = 8 to 34), were measured against good wavelength standards. A short sixth series is identified as $5^2P_{1/2}{}^0-n^2P_{1/2}{}^0$. The accepted value for the ionization potential was confirmed. From a consideration of the character of the perturbations in the n^2D series it is concluded that the $sp\,^2D$ terms lies above the ionization limit, instead of, as formerly supposed, below.

17274 ON THE DETERMINATION OF SPIN POLARIZATION BY ABSORPTION MEASUREMENTS THROUGH OPTICAL PUMPING. W.Raith.
Z. Phys. (Germany),Vol. 163, No. 4, 467-80 (1961). In German.

A simple method has been described (Abstr. 12255 of 1961) for the case of sodium vapour, illuminated by the single circularly polarized D_1 line. It was assumed that the atomic absorption cross-section Q, depending on the degree of polarization P and the frequency of light ν, may be approximated by

$$Q(P,\nu) = (1 - P) \cdot Q\,(P = 0,\nu),$$

and the qualifications relating to this are here discussed. A theoretical analysis of the pumping process is tried, showing that the measured polarization corresponds in good approximation to the degree of the valence electron spin polarization. For the case of weak absorption and equal intensity of the two hyperfine components of the D_1 line, a diagram is given relating the measured polarization to that of the nuclear spin.

17275 THEORY OF MODULATION OF LIGHT IN A DOUBLE RESONANCE EXPERIMENT.
J.N.Dodd and G.W.Series.
Proc. Roy. Soc. A (GB), Vol. 263, 353-70 (Sept. 19, 1961).

A theory is formulated to describe the modulation which has been observed in fluorescent light from atoms subjected simultaneously to optical and radio-frequency radiation. The optical field stimulates one or more of a set of excited states of the atom, between which the radio-frequency field establishes coherence. This coherence is manifest in the fluorescent radiation. Interference between radiations of different frequency leads to modulation. General expressions are given for the intensity of the fluorescent light as a function of time. The Zeeman structure of the transition ($6^3P_1-6^1S_0$), λ 2537 A, in mercury was studied in detail. Modulation at frequencies, 1, 2, 3 and 4 times that of the radio-frequency field, ω_0, is predicted and resonant effects at static magnetic fields, 0, $\frac{1}{2}$, 1, $\frac{3}{2}$, 2 and 3 times H_0, the field for which ω_0 is the Larmor frequency. Resonances at fields other than H_0 are due to excitation with light of mixed polarization. Most of the predicted effects were found experimentally. A "frequency diagram" is introduced and discussed, to represent the combined effects of static and radio-frequency magnetic fields. To each excited state belongs a set of r frequencies, where r is the number of states linked by the radio-frequency perturbation. The 9 levels are drawn, as functions of H, for the states $m_J = 0, \pm 1$, of $^3P_1$. The resonances at fields other than H_0 may be associated with intersections of frequency levels belonging to different m_J. See also following abstract.

17276 DENSITY MATRIX FORMALISM APPLIED TO LIGH BEAT EXPERIMENTS. J.P.Barrat.
Proc. Roy. Soc. A (GB), Vol. 263, 371-7 (Sept. 19, 1961).

A density matrix formalism is developed to account for vari coherence effects observed in double resonance experiments (see preceding abstract). It is shown in particular that the inten of the resonance light can be modulated at frequencies $p\omega/2\pi$ (p = 1, 2, 3, 4), where $\omega/2\pi$ is the radio frequency. Explici expressions are derived in the case of the 6^3P_1 state of the even isotopes of mercury.

17277 THE POLARIZATION OF RECOMBINATION RADIATION. B.A.Lÿsov, L.P.Belova and L.I.Korov
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 4, 1160-5 (April, 196
In Russian.

The polarization of radiation following the capture of a relativistic electron into the K-shell is considered. Partial elliptical polarization is shown to occur in this case. The expre for the intensity of the unpolarized part of the radiation is given. The electron–spin contribution is discussed. The calculations are performed to the lowest order in αZ. [English translation i Soviet Physics–JETP (USA), Vol. 13, No. 4, 816-19 (Oct., 1961)]

17278 PRODUCTION OF NEGATIVE-TEMPERATURE STATES BY ELECTRON EXCITATION IN A GAS MIXTURE. N.G.Basov and O.N.Krokhin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1777-80 (Dec., 196
In Russian.

The conditions for the production of negative-temperature states by electron-beam excitation in a mixture of two gases wit identical energy levels are considered. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 6, 1240-2 (June, 1961)]

17279 SCATTERING OF LOW-ENERGY ELECTRONS BY ATOMIC HYDROGEN.
R.H.Neynaber, L.L.Marino, E.W.Rothe and S.M.Trujillo.
Phys. Rev. (USA), Vol. 124, No. 1, 135-6 (Oct. 1, 1961).

The total cross-section for the scattering of electrons by atomic hydrogen was measured as a function of electron energy from 3.1 to 12.3 eV. The basic measurement compared the number of electrons scattered from a region defined by the inter section of an electron beam and a chopped molecular beam with number scattered when the hydrogen beam was partially dissocia By measuring the degree of dissociation with a mass spectromet one may obtain the ratio of cross-sections of atomic and molecul hydrogen for a given energy. The absolute values were calculate from these ratios and molecular hydrogen values obtained from literature. In the experiment most of the scattered electrons we detected (the angular resolution was about 25°), thereby differing from a previous measurement by Brackmann, Fite and Neynaber (Abstr. 6174 of 1959). The present results are in good agreemen with several theoretical estimates, e.g., that of McEachran and Fraser.

17280 EXPERIMENTAL STUDY OF THE CHARGE DISTRIB TION OF O^{16} AND O^{18} BY ELECTRON SCATTERING
F.Lacoste and G.R.Bishop.
Nuclear Phys. (Internat.), Vol. 26, No. 3, 511-26 (Aug., 1961).

The elastic scattering cross-sections for 150 MeV electrons O^{16} and O^{18} were compared for the scattering angles $\theta = 60^0$, 100^0 and 110^0. The inelastic cross-section on O^{16}, up to 6 MeV excitation energy, was measured for the same angles. From the results one can deduce: (1) The difference between the length parameters of the harmonic well potential for O^{16} and O^{18}. If $a_{18} = (1 + \epsilon)\, a_{16}$, this experiment gives $\epsilon = (2.5 \pm 0.6) \times 10^{-2}$. (2) lifetime of the 1.98 MeV excited state of O^{16} is $\tau = (3.3 \pm 1.5) \times 10^{-12}$

17281 ASYMPTOTIC PHASE SHIFTS AND DIFFERENTIAL CROSS-SECTIONS FOR THE SCATTERING OF ELEC RONS BY ATOMS WITH A LATTER POTENTIAL. T.Tietz.
Ann.Phys. (Germany), Vol. 8, No. 1-2, 99-103 (1961). In German

The potential considered is $V(r) = -(Ze^2/r)\,\varphi(r/\mu)$ for $Ze^2\varphi/r > e^2/r$, and zero otherwise, where φ is the Thomas–Fer function of the free neutral atom, μ being the usual scaling para meter. φ is approximated by Buchdahl's expression (Abstr. 608 of 1956). An expression in a closed form for the phase shifts is derived in the WKB approximation and from this the differential cross-section is evaluated. L.Pinch

17282 ELASTIC SCATTERING OF LOW ENERGY POSITRO BY ATOMS. F.B.Malik.
Z. Naturforsch. (Germany), Vol. 16a, No. 5, 500-10 (May, 1961).

Elastic scattering cross-sections of low energy positrons (

10 eV) by He, C, N, O, F, Ne and A atoms are calculated by ional methods. The scattering potentials are taken to be the ical approximations of different Hartree potentials. Only e is included. Comparisons with the available experimental f positron scattering by He, Ne and A reveal that either a erably strong polarization potential is required to bring the tical results at par with experiments or the formation of l positronium plays a dominant role for this kind of elastic ring.

83 PARTIAL WAVE THEORY OF POSITRON—HYDROGEN ATOM COLLISIONS. K.Smith.
Phys. Soc. (GB), Vol. 78, Pt 4, 549-53 (Oct., 1961).
eals with the derivation of the radial equations for positron— gen atom collisions from the continuous state Hartree—Fock ons. The angular coefficients are expressed in terms of addition coefficients and Racah coefficients for any angular ntum state of the atomic systems: positronium and atomic gen. The boundary conditions are written in terms of the rix and expressions are obtained for total and differential -sections.

84 ELECTRON CAPTURE IN FAST COLLISIONS. I. CAPTURE BY FAST PROTONS IN ATOMIC OGEN. M.R.C.McDowell.
Roy. Soc. A (GB), Vol. 264, No. 1317, 277-88 (1961).
ormal perturbation theory is employed to obtain the matrix nt for electron capture by fast particles of mass M_B and e Z_B from atoms of mass M_A and charge Z_A, allowing for ternuclear potential and distortion by the incoming particle. it formulae are presented for the 1s—1s transition. Detailed ations were carried out for protons in atomic hydrogen. For ase distortion significantly reduces the cross-section at n energies below 100 keV, but at higher energies its effects and of the internuclear potential largely cancel each other.

85 ATOMIC SCATTERING FACTORS FROM WAVE FUNCTIONS CALCULATED BY THE POLY-DETOR HOD: Cl, Cl^-, S AND S^-. B.Dawson.
cryst. (Internat.), Vol. 13, Pt 5, 403-8 (May, 1960).
Earlier atomic scattering factors used for Cl, Cl^- and S in ture analysis are discussed, and new scattering factors for atoms, and for S^-, reported. The new results are based on ound-state atomic wave-functions of Boys and Price (Abstr. of 1954) calculated by the variational poly-detor method. A description of this method is given with regard to certain es of these wave-functions, and it is shown that the atomic ering factors obtained here represent good, spherically- ged, approximations to the scattering powers of these atoms solid state. The new results are compared with those ed from self-consistent field and Slater wave-functions, e differences discussed.

86 X-RAY SCATTERING FACTORS OF TWO-ELECTRON IONS FROM RADIALLY AND ANGULARLY CORRELAT- AVE FUNCTIONS. J.N.Silverman, O.Platas and F.A.Matsen.
cryst. (Internat.), Vol. 13, Pt 7, 539-42 (July, 1960).
The X-ray scattering factors for helium and helium-like ions alculated with radially and angularly correlated wave-functions. energy criterion for quality of wave-functions is used, these actors are more reliable than those previously derived from lly correlated and restricted Hartree—Fock functions. In el trend with the relative magnitude of the electronic correla- nergy, the correlation effects on the scattering factors are pronounced for the lowest member of the isoelectronic series, nd diminish rapidly with increasing nuclear charge. The lations can be extended to polyelectronic ions without great ulty.

87 THREE-TERM HYLLERAAS-FUNCTION ATOMIC SCATTERING FACTORS FOR THE TWO-ELECTRON . R.P.Hurst.
cryst. (Internat.), Vol. 13, Pt 8, 634-8 (Aug., 1960).
The three term Hylleraas function $\psi = [1 + c_1 u + c_2 t^2] \exp(-\alpha s)$ ed to determine the atomic scattering factors for the helium- ons. Though some systematic differences are noted, previous consistent field and radially correlated factors are found to good agreement with present results. It is found that the d correlation introduced by use of the so-called "open shell" oximation tends to slightly overemphasize the correlation effect. one introduces angular correlation as well, the shift in the d distribution is slightly reduced. Finally, it is noted that the scattering factors from the Hylleraas function tend to be smaller than those computed from hydrogenic charge distributions (hydrogenic charge distribution with a scale factor) at small Bragg angles and larger at the large Bragg angles. An explanation for this latter effect is given.

17288 KRYPTON—KRYPTON MOLECULAR INTERACTION. A.K.Barua and P.K.Chakraborti.
Physica (Netherlands), Vol. 27, No. 8, 753-62 (Aug., 1961).
The potential energy of interaction of krypton on a six-parameter model was obtained mainly from the various crystal properties. The new potential energy curve is more logical than those on the usual two- or three-parameter models (e.g. exp-6, L-J (6—12) etc.), It was found that the force constants on the L-J (6—12) model derived from the constants on the six-parameter model can correlate the various transport and the equilibrium properties of krypton with reasonable success. This result is in contradiction to the results obtained recently by Mason from an analysis of the transport properties data only.

17289 VAN DER WAALS FORCES FOR HYDROGEN AND THE INERT GASES. A.Dalgarno and A.E.Kingston.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 607-9 (Oct., 1961).
Experimental data and theoretical calculations on neon and argon are analysed to yield consistent sets of electric dipole oscillator strengths. The derived oscillator strengths are used with known values for hydrogen and helium to calculate the van der Waals energies between all pairs of atoms selected from hydrogen, helium, neon and argon. The results are summarized in a table. The probable error is less than 10%.

17290 SPIN-CHANGE CROSS-SECTIONS. A.Dalgarno.
Proc. Roy. Soc. A (GB), Vol. 262, 132-5 (June 13, 1961).
A quantal formulation of spin-change processes in collisons of atomic systems is presented. The cross-section for the spin-change process in the collision of two hydrogen atoms is computed for temperatures up to 10 000°K and the results given in a table.

17291 RESONANCE CHARGE EXCHANGE IN HYDROGEN AND SODIUM. Yu.E.Murakhver.
Zh. eksper. teor. Fiz. (USSR), Vol. 13, No. 4, 1080-4 (April, 1961).
In Russian.
Two problems are considered within the framework of the parametric method: (1) Resonance charge exchange of protons in atomic hydrogen. Its probability at all velocities can be expressed through a single integral involving Hankel functions. A numerical calculation is carried out for a single value of the velocity v of the relative motion of the nuclei; (2) Single resonance charge exchange of Na^+ ions in sodium. Up to the present, charge exchange involving complex atoms has been considered in the hydrogen-like approximation. Here the calculation is based on analytical wave-functions and the analytical expression for the field of the atomic core. The expressions approximate the corresponding quantities computed by the Hartree—Fock method. Results are obtained for all values of v (within the limits of applicability of the parametric method).
[English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 4, 762-5 (Oct., 1961)].

Isotopes

ISOTOPE ABUNDANCE IN MERCURY. See Abstr. 16081

17292 AUTOMATIC MASS NUMBER DETERMINATION FOR ISOTOPE SEPARATORS AND MASS SPECTROMETERS. L.Wåhlin.
Nuclear Instrum. and Methods (Internat.), Vol. 9, No. 1, 21-8 (Oct.,1960).
Determinations are possible by means of an electronic computer system. A detailed description of this method, as applied to the separator in Pretoria is given. For an account of the separator see Abstr. 2303 of 1961.

17293 EVIDENCE OF A PROCESS CAUSING CONTAMINATION IN ELECTROMAGNETIC ISOTOPE SEPARATORS. R.Bernas.
J. Phys. Radium (France), Vol. 21, No. 6, 566-8 (June, 1960).
In French.
Describes experiments carried out to investigate the contamina-

tion in the separated samples of electromagnetic separators. The apparatus used was the two-stage Orsay separator. R.H.Thomas

17294 A DOUBLE MAGNETIC DEFLECTION ISOTOPE SEPARATOR FOR THE PRODUCTION OF VERY HIGH PURITY ISOTOPES. R.Bernas, J.L.Sarrouy and J.Camplan.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 191 A-203 A (Nov., 1961). In French.

The electromagnetic separator of the Nuclear Physics Laboratory of Orsay is made up of a 60^0 sector homogeneous magnetic field analyser followed by a semicircular inhomogeneous field analyser of the Svartholm–Siegbahn type. The enrichment factors reached are from ten to a hundred times higher than those obtained with the other types of separators while the ion beam intensity remains in the neighbourhood of 1 mA. A description of the instrument is given as well as the first results obtained in the separation of the isotopes of a few elements: Cr, Sr, Yb, Hg, U, etc.

17295 ISOTOPE SEPARATION IN A CIRCULAR FLOW. H.J.Mürtz and H.G.Nöller.
Z. Naturforsch. (Germany), Vol. 16a, No. 6, 569-77 (June, 1961). In German.

If a gas mixture is fed tangentially into a tube through a converging nozzle with the velocity of sound, then, at pressures below 5 mm Hg, a laminar flow is obtained, which progresses helically along the axis of the tube. As a result of centrifugal forces the space adjoining the axis becomes richer in the lighter component, whereas the heavier component is predominant in the outermost layer (see Abstr. 113 of 1959). The dependence of the separation factor on various parameters is discussed, and the conditions for equilibrium are estimated for various gases, e.g. H_2 and Hg. The separation factors for H_2–HD and A^{36}–A^{40} are 1.13 and 1.12, respectively. F.Lachman

17296 A METHOD FOR THE SEPARATION OF GOLD IRRADIATED MERCURY ISOTOPES. W.Parker.
Nuclear Instrum. and Methods (Internat.), Vol. 8, No. 3, 354 (Sept., 1960).

ISOTOPE EFFECT IN THE ELECTROLYTIC TRANSPORT OF LEAD IONS IN MOLTEN LEAD BROMIDE. See Abstr. 15198

17297 PREPARATION OF CARRIER-FREE Cr^{51}. D.De Soete, J.Hoste and G.Leliaert.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 134-6 (July, 1960).

Details are given of a method for the preparation of carrier-free Cr^{51} from deuteron irradiated vanadium by fractional distillation of a solution of the target in HCl. G.I.W.Llewelyn

ISOTOPE EFFECT IN THE NUCLEAR MAGNETIC RESONANCE IN RUBIDIUM. See Abstr. 14824

Mesic Atoms

17298 AN INVESTIGATION OF THE PARAMAGNETISM OF μ-MESIC ATOMS. L.B.Egorov, G.V.Zhuravlev, A.E.Ignatenko, Li Syuan-Min [Li Hsuang-Ming], M.G.Petrashku and D.Chultém.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 391-99 (Feb., 1961). In Russian.

The nature of the paramagnetism of various mesic atoms was investigated by measuring the asymmetry of μ–e decay electrons. The experimental results indicate that in dielectrics and in normal diamagnetic and weakly paramagnetic metals the paramagnetism of mesic atoms results from the μ^--meson magnetic moment, whereas in paramagnetic transition metals, lanthanides, and actinides it is due to the magnetic moments of both the electron shell and meson. It is shown that polarized mesons can be employed to investigate the magnetic properties of the atoms and hydrides of transition metals, actinides, and lanthanides with zero nuclear spin. [English translation in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 268-73 (Aug., 1961)].

17299 FAST ATOMIC TRANSITIONS WITH μ-MESONIC HYPERFINE DOUBLETS, AND OBSERVABLE EFFECTS OF THE SPIN DEPENDENCE OF MUON ABSORPTION.
R.Winston and V.L.Telegdi.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 104-7 (Aug. 1, 1961).

It is shown that the measurement of electron rates from negative muons stopped in a target of non-zero spin will not sh effects due to the two members of the hyperfine doublet ground state. This is due to a non-negligible transition rate between two states. Possible experiments for detecting spin-dependent effects are discussed. C.J

17300 MEASUREMENTS ON MUON DISAPPEARANCE RA VERSUS TIME IN C, Mg, Al, Si AND P.
J.L.Lanthrop, R.A.Lundy, V.L.Telegdi, R.Winston and D.D.Yavanovitch.
Phys. Rev. Letters (USA), Vol. 7, No. 3, 107-9 (Aug. 1, 1961).

No evidence is found for the observation of spin dependenc the capture of muons by Al. Values for the μ^- lifetime in C, N Si and P are given. C.J

17301 TRANSITIONS BETWEEN HYPERFINE LEVELS IN MESIC DEUTERIUM ATOMS. S.S.Gershtein.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 698-707 (Feb., 19 In Russian.

The effective cross-section for $d\mu$ mesic atom transitions the lower ($F = \frac{1}{2}$) hyperfine state in exchange collisions with de ons is calculated. It is shown that practically complete depola zation of μ mesons should be observed in pure deuterium. It i also shown that the $d\mu$ transition to the $F = \frac{1}{2}$ state increases t capture probability, $\mu^- + d \rightarrow 2n + \nu$ (by a factor of three for V and the effect of the transition to the $F = \frac{1}{2}$ state on the catalysi of the nuclear reaction $p + d \rightarrow He^3$ is discussed. [English tra tion in: Soviet Physics–JETP (USA), Vol. 13, No. 2, 488-94 (Aug., 1961)].

17302 NEGATIVE MUON DECAY IN THE K-SHELL. L.Krüger and J.Rothleitner.
Z. Phys. (Germany), Vol. 164, No. 3, 330-40 (1961). In Germa

The decay rate of bound muons from the K-shell and the spectrum of the decay electrons are calculated for seven elem up to lead. The muon is represented by a non-relativistic wav function in the potential of a realistic nuclear charge distributi The electron wavefunction is expanded in partial waves which the relativistic and the finite nuclear size effects to be taken i account exactly. The decay rate decreases monotonically but slowly with increasing atomic number. This agrees with earli theoretical predictions but contradicts most of the experiment results for both medium and high atomic numbers.

MOLECULES

17303 EXCITED STATES OF MOLECULES AND THE SCATTERING OF FAST ELECTRONS. J.Karle.
J. chem. Phys. (USA), Vol. 35, No. 3, 963-9 (Sept., 1961).

When fast electrons are scattered by molecules which und excitation in the course of the scattering process, the patterns associated with discrete energy losses show the characteristi molecular-diffraction features associated with interatomic dis A theory is developed in agreement with experimental results far obtained which describes the possible forms for these diff tion features, and shows that the molecular scattering does no necessarily disappear on averaging over all states of excitatio has been generally assumed for the "incoherent" scattering. developing the theory, the wave-function for the molecule is fo from a linear combination of atomic orbitals assumed to be S func By means of group theoretical methods the proper linear comb tions of S functions may be composed for the possible types of ed electronic states of the molecule. The theoretical analysis employs the Franck–Condon principle and the Born scattering theory. From the theory developed it is possible to predict an terpret gross features of the molecular scattering from molec in the process of excitation. The accurate prediction of energ changes and atomic background scattering are interesting pro for future consideration. This new electron-diffraction techni should be a valuable adjunct to the field of photon spectroscop

KRYPTON–KRYPTON MOLECULAR INTERACTION. See Abstr. 17288

17304 VIBRATION-ROTATION ENERGY OF POLYATOM MOLECULES. NOTE ON THE TABLES OF SECO ORDER TRANSFORMED HAMILTONIAN COEFFICIENTS.
M.L.Grenier-Besson, G.Amat and S.Maes.
J. Phys. Radium (France), Vol. 21, No. 6, 568 (June, 1960). In French.
See Abstr. 5111 of 1959.

05 RESONANCES AND ROTATIONAL *l*-TYPE DOUBLING IN AXIALLY SYMMETRIC MOLECULES.
ıier-Besson.
s. Radium (France), Vol. 21, No. 6, 555-65 (June, 1960).
ıch.
ıtrix elements of the second-order transformed Hamiltonian
'ch are diagonal in v_t and off-diagonal in l_t and K are re-
ole for rotational *l*-type doubling and resonance. These mat-
ments were calculated as functions of molecular constants:
rium moments of inertia, harmonic force constants, rotation-
on interaction coefficients and coefficients of the anharmonic
otential. The calculation was performed for an axially sym-
molecule belonging to an unspecified symmetry group, with
ation to various particular models.

06 OSCILLATOR FREQUENCY AND VIBRATIONAL QUANTA IN THE HYDROGEN MOLECULE.
ffray and J.W.Cooley.
Rev. (USA), Vol. 124, No. 1, 137 (Oct. 1, 1961).
eoretical values of the oscillator frequency and vibrational
in the electronic ground state of H_2 are obtained and com-
with the corresponding experimental data. Agreement
n the two sets of values is found to be of the order of 1 part
This is somewhat larger than the estimate (2 parts in 10^4)
experimental error.

07 MEASUREMENTS OF ROTATIONAL ENERGY DISTRIBUTIONS IN IONIC COLLISIONS.
eeves and R.W.Nicholls.
Phys. Soc. (GB), Vol. 78, Pt 4, 588-93 (Oct., 1961).
he measured rotational intensity distribution of N_2^+ First
ve bands excited by 1 MeV protons indicates that the
n of the molecules is not greatly affected by the collisions.
red rotational temperatures compare favourably with laboratory
ratures. Similar observations on N_2^+ bands excited by 1 to
Li^+ ions show that these collisions appear to cause a marked
ure from Boltzmann distribution of rotational energies.
y levels of high and of low quantum numbers are enhanced in
tion.

08 FRANK–CONDON FACTORS AND R-CENTROIDS FOR SOME BANDS OF THE SiO $A^1\pi - X^1\Sigma^+$ BAND SYSTEM.
cGregor, R.W.Nicholls and W.R.Jarmain.
J. Phys., Vol. 39, No. 8, 1215-16 (Aug., 1961).
alculations were made for the vibrational bands $v' + v'' \leq 8$
e results are presented in tabular form. G.V.Marr

09 INTERACTION OF THE VIBRATIONAL AND ELECTRONIC MOTIONS IN SOME SIMPLE CONJUGATED OCARBONS. III. A SEMIEMPIRICAL FORMULATION.
iehr.
urforsch. (Germany), Vol. 16a, No. 7, 641-68 (July, 1961).
or Pt I-II see Abstr. 731, 6189 of 1959. A semiempirical
of vibrational and electronic reciprocation, in both degenerate
n-degenerate electronic states, is developed under the
ptions that (1) a molecule may be accurately described by the
tic approximation; (2) solutions of the electronic and vibra-
Schrödinger equations for some fixed molecular conformation
ailable; (3) the electronic wave functions may be analytically
ued to vicinal geometries; (4) the power series expansion of
ectronic wave functions and Hamiltonian operator, in terms of
displacements, may be truncated at degree two; and (5) first
perturbation theory is applicable. The formulae derived for
egenerate electronic distributions are employed to compute
ensities of the Herzberg–Teller (1933) ("vibronic") type
otions of normal benzene, the cyclopentadienide ion, and the
ium ion. For convenience in numerically evaluating the
ite phenomenological vibronic constants, the Lennard-Jones
approximation is introduced. The resultant accord of experi-
and theory is good. To test the deduced mathematical expres-
for either essentially or fortuitously degenerate electronic
itions, extremal energy calculations are performed for the
utadiene and benzene molecules, the cyclotadienyl radical,
e benzene plus one ion. It is found, in agreement with the
-Teller theorem (1937), that all these systems are configura-
ly unstable with respect to some asymmetric nuclear dis-
ent. The utilization of the Lennard-Jones approximation
permits a numerical specification of the required vibronic
eters. Application is then made to the ultra-violet spectrum
zene: the second singlet absorption and the Rydberg spectrum
eoretically interpreted in the light of the reckoned predictions.
An attempt is made to answer the four cogent queries of Wilkinson (Abstr. 4993 of 1956) concerning the nature of Jahn–Teller interactions in the Rydberg spectrum of benzene. A mathematical and pictorial description of the nuclear dynamics of Jahn–Teller and Herzberg–Teller molecules is also given, and the portraitures of the underlying potential surfaces are verbally and diagrammatically painted. In addition, a critical discussion of the reality of both the computational techniques and of the emergent algebraic forms is presented, and paths for future progress are indicated. A critical discussion on the misuse of the phrase "Jahn–Teller effect" is appended; it is recommended that its use be restricted to the dynamical manifestations of the theorem of Jahn and Teller (e.g., forbidden asymmetric vibrational progressions and abnormal paramagnetic behaviour). Statical demonstrations of the theorem are better ascribed to intrinsic Jahn–Teller instability.

VIBRATION–ROTATION STRUCTURE IN ABSORPTION BANDS FROM 2 TO 16 MICRONS. See Abstr. 16075

VIBRATIONAL TRANSITION PROBABILITIES OF CARBON MOLECULE. See Abstr. 15505

INFRARED REFLECTION SPECTRA OF LIQUID LITHIUM, SODIUM, POTASSIUM, AND SILVER NITRATES. See Abstr. 15885

17310 A NEW METHOD FOR PRODUCING THE AURORAL AFTERGLOW OF NITROGEN AND ITS SPECTRUM.
Y.Tanaka and A.S.Jursa.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1239-45 (Nov., 1961).
In this method no pre-operation of the afterglow tube is required and the afterglow is much stronger than that produced by Kaplan's method. The spectrum of the auroral afterglow is analysed. In the first-positive system, the vibrational levels of the upper state were extended to v = 26 and for the lower state to v = 20. In the second-positive system, new bands were observed which have been tentatively ascribed to a transition from v' = 5. It was determined that the Goldstein–Kaplan bands belong to a single system, the $^3\Pi - B^2\Pi_g$. Three heads were measured for each band of the G–K system. The Vegard–Kaplan bands and the first-negative system were also observed and are reported on. The lifetime of the auroral afterglow and the excitation processes for the afterglow are discussed.

EMISSION SPECTRA FROM THE POSITIVE COLUMN IN THE GLOW DISCHARGE THROUGH VAPOURS OF MONOHALOGEN BENZENES. See Abstr. 16286

17311 SPECTRUM OF NBr EXCITED IN ACTIVE NITROGEN.
E.R.V.Milton, H.B.Dunford and A.E.Douglas.
J. chem. Phys. (USA), Vol. 35, No. 4, 1202-11 (Oct., 1961).
The spectrum of NBr near 6000 A, excited by the action of active nitrogen on bromine, was photographed at high dispersion and the rotational structure of the bands has been analysed. The bands are attributed to a $^1\Sigma^+ - ^3\Sigma^-$ transition in which the $^3\Sigma^-$ state is the ground state of the molecule. Only two of the five possible branches were observed both of them belonging to the $F_1(J = N + 1)$ component of the $^3\Sigma^-$ state. The unusual structure of the bands is attributed to the fact that the coupling in the $^3\Sigma^-$ state is intermediate between Hund's case b and case c. The equilibrium internuclear distances are $r_e' = 1.731$ A and $r_e'' = 1.79 \pm 0.92$ A and the dissociation energy is estimated to be 67 ± 5 kcal. The emission spectrum is believed to be caused by the combination of $N(^4S)$ and $Br(^3P_{3/2})$ atoms into some unknown excited state of NBr which is induced, by wall collisions, into the $^1\Sigma^+$ state.

17312 OBSERVATION OF THE $(b^1\Sigma_g^+ - a^1\Delta_g)$ TRANSITION IN O_2. J.F.Noxon.
Canad. J. Phys., Vol. 39, No. 8, 1110-19 (Aug., 1961).
The Q branch of the (0,0) band of the electric quadrupole $(b^1\Sigma_g^+ - a^1\Delta_g)$ transition in O_2 was observed at 1.908 μ in the emission spectrum of a discharge through O_2 and He. By a comparison with the (0,0) atmospheric O_2 band $(b^1\Sigma_g^+ - X^3\Sigma_g^-)$, the absolute transition probability for the (b–a) system was found to be 2.5×10^{-3} sec^{-1}, with an uncertainty of a factor of 2. The (0,0) band of the infrared atmospheric $(a^1\Delta_g - X^3\Sigma_g^-)$ system of O_2 was also observed in emission. Using the observed intensity of the (0,1) atmospheric O_2 band in the aurora and airglow one may predict that the (0,0) (b–a) band should be detectable in a strong aurora if observations are made from high altitude.

17313 SPECTRA AND ENERGY TRANSFER PHENOMENA IN CRYSTALLINE RARE GAS SOLVENTS.
G.W.Robinson.
J. molecular Spectrosc. (USA), Vol. 6, No. 1, 58-82 (Jan., 1961).

The use of crystalline nonpolar gases at 4.2°K as solvents allows one to study spectra, solvent shifts, and energy transfer phenomena over a wide range of solvent properties. Contributions to the spectral shifts may arise from the usual London dispersion energy, exchange repulsions and attractions, and dipole-induced-dipole interactions. Except for the frequency shifts and certain intensity perturbations, the spectrum of a nonpolar solute in this sort of an environment is like that of a randomly oriented gas at 4.2°K. The advantages associated with the vibrational analysis of such a spectrum are obvious. A striking perturbation on the phosphorescence lifetime of benzene in heavy rare gases has been explained on the basis of an exchange interaction mixing states of the benzene–rare-gas complex, whose Russell–Saunders components are further mixed by the large rare-gas spin-orbit perturbation. The oscillator strength for the purely radiative $^3B_{1u}$-$^1A_{1g}$ transition in unperturbed benzene is found to be 7.7×10^{-11}, and it is estimated that a 150 cm path of highly purified liquid benzene should be sufficient to observe in absorption the first strong band of this system predicted to lie near 31 000 cm^{-1}. One of the most important factors in a nonradiative process is the vibrational overlap integral associated with the two vibronic states between which energy transfer occurs. A type of tunnelling from the lowest triplet state back to the ground singlet state has been found. It involves usually high vibrational quantum numbers of the ground state. Because of the high sensitivity of the overlap integral to triplet states are therefore probably tunnelling lifetimes and have little to do with the purely radiative lifetimes. Deuterium substitution is expected to increase these lifetimes substantially and allow a number of new triplet states to be found. Energy transfer from the excited singlet to the excited triplet has been found to be highly sensitive to local solvent environment. This process apparently can be essentially stopped or made 100% efficient at will simply by changing the mass of the solvent molecules. This phenomenon is no doubt a function of the strength of the coupling between the internal modes and the lattice modes, the coupling being dependent, of course, on the polarizability of the solvent. Solid hydrogen or neon solvents are expected to provide the least opportunity for energy transfer during an electronic lifetime.

17314 GROUP THEORY TREATMENT OF THE MICROWAVE SPECTRUM OF MOLECULES WITH HINDERED ROTATION OF TWO METHYL GROUPS, WITH DIFFERENT CARBON ISOTOPES. H.Dreizler.
Z. Naturforsch. (Germany), Vol. 16a, No. 5, 477-84 (May, 1961). In German.

The theory of double-rotor molecules is extended to cases such as $C^{12}H_3.S.C^{13}H_3$, in which isotopic substitution reduces the symmetry to C_{1v} or C_1. The Hamiltonian, invariant with respect to a group of 18 symmetry operations, is developed to yield the degeneracies of the eigenvalues and the selection rules. Only non-degenerate and doubly degenerate eigenvalues are present, the four-fold degeneracy, occurring without the C^{13} substitution, being absent. A simplified approximate Hamiltonian is used to derive the splittings of the rotational lines, in the extreme case into quintuplets, and the relative intensities of components. Nuclear spin statistical effects are also considered. The calculations are capable of extension to higher torsional states and different spin statistics. J.Sheridan

17315 THE MICROWAVE ROTATION SPECTRUM OF INDIUM MONOCHLORIDE. J.Hoeft.
Z. Phys. (Germany), Vol. 163, No. 3, 262-76 (1961). In German.

Rotational constants (B_e) and vibration–rotation interaction constants (α_e) were determined for $In^{113}Cl^{35}$, $In^{113}Cl^{37}$, $In^{115}Cl^{35}$ and $In^{115}Cl^{37}$ from measurements of their $J = 1 \rightarrow 2$ transitions at their natural isotopic concentrations (1-72%). Quadrupole coupling constants were determined for all nuclei in each of these molecules, except $In^{113}Cl^{37}$, where only the indium coupling was derived. The accuracy of quadrupole coupling constants was some ten times that of earlier work on $In^{115}Cl^{35}$ (see Abstr. 2241 of 1958), and the quadrupole coupling of chlorine is less than formerly believed. The coupling of In^{115} in the ground and first two excited vibrational states of $In^{115}Cl^{35}$ and $In^{115}Cl^{37}$ falls approximately linearly with the increase in average (r_0) nuclear separation caused by vibration. J.Sheridan

17316 INFRARED SPECTRUM OF ACETYLENE.
T.A.Wiggins, E.K.Plyler and E.D.Tidwell.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1219-25 (Nov., 1961).

The infrared absorption spectrum of C_2H_2 was studied in th region from 2500 to 4150 cm^{-1}. Nineteen bands were observed which 11 were sufficiently intense and well resolved to permit rotational analysis. Five bands involving the ground vibrationa state were analysed giving the rotational constants $B_0 = 1.1765_4$ ± 0.00004 and $D_0 = 1.51 \pm 0.03 \times 10^{-6}$ cm^{-1}. The l-doubling constants for the degenerate modes were $q_4 = 5.2_7$, $q_5 = 4.6_3 \times$ cm^{-1}. The rotational constants determined for the various obs states clearly show that additional data will be needed and due account taken of resonances to obtain a satisfactory set of rota constants. The use of difference bands involving the $v_4 = 1$ leve permits the determination of the vibrational frequency of that l to be 612.88 cm^{-1}.

INFRARED SPECTRUM AND MOLECULAR CONFI TION OF GLUTARONITRILE. I.Matsubara.
J. chem. Phys. (USA), Vol. 35, No. 1, 373-4 (July, 1961).

A study of the spectrum in the region 1500-400 cm^{-1} for b the liquid and crystalline states reveals the presence of three rotational isomers: TT, TG, and GG. It is found that the TT isomer exists only in the liquid state. In the solid state, depen on the mode of crystallization, there is evidence for a metastab and a stable phase. These phases are ascribed to the TG and G isomers respectively. D.L.Gre

17318 INFRARED SPECTRUM OF CF_3SF_5.
D.F.Eggers, Jr, H.E.Wright and D.W.Robinson.
J. chem. Phys. (USA), Vol. 35, No. 3, 1045-50 (Sept., 1961).

The infrared spectrum of CF_3SF_5 was measured and analy between 30 and 4000 cm^{-1}. A band found at 218.5 cm^{-1} is belie responsible for satellite lines observed previously in the micr spectrum; the barrier to internal rotation might then be much l than obtained previously by assuming these satellites were due torsional oscillation. Twelve of the seventeen fundamentals we assigned in the infrared spectrum and estimates are given for others. A plausible assignment is given for the overtone and c bination bands also observed; this gives no evidence for any of inactive fundamentals.

17319 INFRARED SPECTRUM AND STRUCTURE OF TH RADICAL.
M.D.Harmony, R.J.Myers, L.J.Schoen, D.R.Lide, Jr and D.E.M
J. chem. Phys. (USA), Vol. 35, No. 3, 1129-30 (Sept., 1961).

The infrared spectrum of NF_2, formed by dissociation of N at temperatures between 25° and 175°C, showed bands centred 1074 and 930-940 cm^{-1}, which were attributed to stretching mo The F–N–F angle was found to be 104.2°. Bands centred at 1 and 930.7 cm^{-1} were observed due to NF_2 trapped in an N_2 mat at 20°K. E.F.W.Sey

17320 NEW EMISSION BANDS OF N_2^+, $^2\Pi_g$–$A^2\Pi_u$.
Y.Tanaka, T.Namioka and A.S.Jursa.
Canad. J. Phys., Vol. 39, No. 8, 1138-45 (Aug., 1961).

Thirty-eight new bands of nitrogen were observed in the r 2050-3070 A in an a.c. condensed discharge of neon mixed with small amount of nitrogen. It was determined that these bands from the transition $^2\Pi_g$–$A^2\Pi_u$ of N_2^+.

17321 NEW SPECTRUM OF CF^+.
R.D.Verma.
Canad. J. Phys., Vol. 39, No. 9, 1377-83 (Sept., 1961).

A spectrum ($A^1\Pi$–$X^1\Sigma^+$) of CF^+ was obtained for the first in the region 2025-1900 A. The rotational and the vibrational analyses are given. The principal constants of the two states, evaluated, are given below in cm^{-1}, except for r_e which is give angstroms:

	T_e	ω_e	$\omega_e x_e$	B_e	α_e	r_e
$^1\Sigma^+$	0	1402.18	11.807	1.5172	0.01877	1.22
$^1\Pi$	51157.08	1266.77	13.73	1.4239	0.01945	1.26

A brief discussion of the electron configurations is given.

17322 LOW-RESOLUTION ANALYSIS OF THE $n \rightarrow \pi^*$ (30 ABSORPTION SPECTRUM OF s-TRIAZINE.
J.S.Brinen and L.Goodman.
J. chem. Phys. (USA), Vol. 35, No. 4, 1219-25 (Oct., 1961).

The 3000 A absorption band was examined under low resol

e long wavelength portion is assigned to the allowed $n \rightarrow \pi^*$ tion $^1A_2'' \leftarrow {}^1A_1'$ with 0–0 band at 31 574 ± 15 cm^{-1}. Evidence sented for the onset of a second $n \rightarrow \pi^*$ transition at 00 cm^{-1}. The observed sequence of states contradicts previous tions based on approximate sp^2 hybridization, and indicates the excited states the n orbital has very little s character).

323 MOLECULAR SPECTRA IN THE VACUUM ULTRAVIOLET. P.G.Wilkinson.
lecular Spectrosc. (USA), Vol. 6, No. 1, 1-57 (Jan., 1961).
acuum ultraviolet spectra of diatomic molecules since 1950, olyatomic molecules since 1940 are reviewed in detail. In on to a theoretical discussion, the data obtainable are nted in the form of tables which list the spectral region, ular constants, characteristics of the transitions, intensity ionization potentials, and references. A brief discussion of plication of the data to astrophysical problems is presented.

324 THE ABSORPTION SPECTRUM OF THE BiF MOLECULE IN THE ULTRA-VIOLET REGION. K.C.Joshi.
Phys. Soc. (GB), Vol. 78, Pt 4, 610-13 (Oct., 1961).
ne system, comprising thirty-two bands, of the BiF molecule btained in absorption in the region λλ2400-2180. Three of bands were previously observed in emission by Rochester. ands were analysed and can be represented by the following la:

$$\nu_{v'v''} = 44222.0 + 615.0(v' + \tfrac{1}{2}) - 2.50(v' + \tfrac{1}{2})^2 - 512.0(v'' + \tfrac{1}{2}) + 2.25(v'' + \tfrac{1}{2})^2.$$

cussion regarding the electronic states involved in the tran- shows that the ground state is a triplet state, whereas the one is a single state and not otherwise as suggested by ester.

THEORY OF ELECTRONIC-VIBRATIONAL TRANSITIONS IN EMS WITH MANY VIBRATIONAL DEGREES OF FREEDOM. bstr. 14586

325 THE GROUND STATE OF THE HYDROGEN MOLECULE ON THE BASIS OF RELATIVISTIC NTUM MECHANICS WITH THE AID OF THE WING WAVE CTION. II. THE RELATIVISTIC CORRECTION ENERGY MS. J.Ladik.
phys. Hungar., Vol. 13, No. 2, 123-37 (1961).
For Pt I see Abstr. 5961 of 1960. Reviews the expectation s calculated with the Wang (1928) approximate wave function relativistic correction terms resulting from the treatment ground state of the hydrogen molecule on the basis of the (1929) equation. The difficulties encountered in the calcu- of the part due to retardation of the orbit–orbit magnetic action term and the procedure of calculation of another y term having no non-relativistic counterpart are described. e spin–orbit interaction terms and the first part of the spin– interaction term identically equal zero for any two-electron m of opposite spin, in the ground state of the hydrogen cule only the second part of the spin–spin interaction term s from zero. This energy term is shown to be twice as large e of the terms of the energy having no non-relativistic counter- For the sum of the relativistic correction terms $+1.21 \times 10^{-4}$ eV tained, by approximating the value of the magnetic orbit– interaction term by putting it equal to the expectation value non-retarded interaction operator, which improves the agree- hitherto existing between the experimental and the best etical values of the binding energy of the H_2 molecule. The on for the remaining discrepancy is, in addition to the above ction, that the expectation values of the correction terms are lated instead of with the accurate James–Coolidge wave ion (1933) with the Wang wave function giving a worse approxi- on; further that the elementary mass correction and the mass ization corrections are neglected.

7326 APPROXIMATE DETERMINATION OF THE MOST IMPORTANT RADIATION CORRECTION ENERGY MS FOR THE GROUND STATE OF THE HYDROGEN ECULE. J.Ladik.
phys. Hungar., Vol. 13, No. 2, 139-44 (1961).
The most important radiation-corrected energy terms for the nd state of the hydrogen molecule can be obtained by modify- ppropriately the expression for the helium atom. The expression becomes

$$\Delta E_J^{H_2} = 2E_{L,1}^{H} - E_L^{H_2} - E_L^{H_2}$$

where $E_{L,1}^{H}$ is the Lamb shift for a free hydrogen atom, having a value 3.36×10^{-5} eV; $E_L^{H_2}$ is a term giving approximately the radiation interaction between the electrons, having a value -0.63×10^{-5} eV; and $E_L^{H_2}$ is a term describing the expectation value of the Lamb shift, having a value 10.12×10^{-5} eV. Substituting the above values, $\Delta E_J^{H_2} = -1.77 \times 10^{-5}$ eV. This value is lower than the corresponding value obtained for the ground state of the He atom by an order of magnitude. Furthermore, it does not influence the theoretical value of the binding energy of the H_2 molecule, so far determined to an accuracy of 10^{-4} eV.

17327 CALCULATION OF THE ν_2 AND INVERSION ENERGY LEVELS FOR AMMONIA AND SOME OF ITS ISOTOPICALLY SUBSTITUTED SPECIES. T.P.Norris and J.M.Dowling.
Canad. J. Phys., Vol. 39, No. 8, 1220-3 (Aug., 1961).

Previous calculations (Abstr. 1661 of 1935) are refined to obtain better parameters for the potential function and to determine the energy levels for NH_3, NH_2D, ND_2H, and NT_3. The results of the calculations are presented in tabular form and where possible compared with experimentally determined values of the energy levels. G.V.Marr

17328 FIRST EXCITED $^1\Sigma_g^+$ STATE OF THE HYDROGEN MOLECULE. E.R.Davidson.
J. chem. Phys. (USA), Vol. 35, No. 4, 1189-1202 (Oct., 1961).

A variation calculation on the first excited $^1\Sigma_g^+$ state of H_2 is carried out using an expansion in elliptical coordinates. All results are reported in Hartree atomic units. The potential function resulting from this calculation is characterized by having minima at R = 1.9 and R = 4.3 and a maximum at R = 3.3. The energy obtained at R = 1.9 using a 20-term, open-shell, covalent-type wave-function was –0.7162 as compared with the "experimental" value of –0.7181. Due to convergence difficulties, many more configurations are required to improve this result significantly. At R = 4.3, on the other hand, the best result was obtained with an open-shell wave-function including nine ionic terms and nine atomic terms. This result of –0.7007 is below the reported "experimental" value of –0.6935 because the two lowest $(2p\sigma)^2$ $^1\Sigma_g^+$ vibrational levels have not been found experimentally. The energy at the top of the barrier was computed to be –0.6844 and probably is as low as –0.6884. The vibrational levels for this potential function were computed by a numerical integration technique. The fact that there are in one-to-one correspondence with a combination of the experimental 1s2s and $(2p\sigma)^2$ levels indicates that both of these sets of levels belong to the first excited state.

17329 ELECTRONIC SPECTRA AND HYDROGEN BONDING. I. PHENOL AND NAPHTHOLS. H.Baba and S.Suzuki.
J. chem. Phys. (USA), Vol. 35, No. 3, 1118-27 (Sept., 1961).

The effect of hydrogen bonding on the electronic absorption spectra of phenol, α naphthol, and β naphthol was investigated with particular attention to the relation between the nature of electronic transitions and their behaviour in hydrogen bond formation. The spectra were obtained down to 2000 A in iso-octane solution in the presence of varying concentrations of dioxane. From the analysis of the observed spectra, the equilibrium constants for the hydrogen bonds and the spectra of the hydrogen-bonded species were determined. The hydrogen bond energies are given for the ground and excited states of the solute molecules. The experimental results clearly indicate that effects of hydrogen bonding on electronic spectra differ markedly with transitions. Both the frequency shifts and the intensity changes differ in magnitude and even in sign according to the properties of the transitions concerned. It is shown that the transition at 47 000 cm^{-1} of α naphthol is displaced to higher frequencies upon formation of the hydrogen bond. No appreciable changes are produced by hydrogen bonding in the spectral patterns of the individual transitions, aside from broadening or smoothing of the vibrational structure. The behaviour of the transitions in hydrogen bond formation is interpreted on the basis of the electronic structure of the solute molecules. Two factors are shown to be important for accounting for the mechanism of the hydrogen bonding effect: (a) a change in the electron density at the oxygen atom of the O–H group accompanying an electronic transition: (b) a decrease in the electronegativity of the same oxygen atom resulting from hydrogen bond formation.

17330 MEAN LIFETIME OF THE LOWEST EXCITED SINGLET STATE OF BENZENE.
J.W.Donovan and A.B.F.Duncan.
J. chem. Phys. (USA), Vol. 35, No. 4, 1389-91 (Oct., 1961).

The lifetime of the first excited $^1B_{2u}$ state of benzene was determined from measurement of decay of fluorescence in the vapour phase. High-frequency electrical excitation, rather than optical excitation was used. The pressure dependence of the lifetime has been studied under different conditions. The lifetime extrapolated to zero pressure is 0.59 μsec. The pressure dependence is interpreted by a mechanism of collisional deactivation.

17331 POLARIZATIONS AND ASSIGNMENTS OF TRANSITIONS: THE METHOD OF PHOTOSELECTION.
A.C.Albrecht.
J. molecular Spectrosc. (USA), Vol. 6, No. 1, 84-108 (Jan., 1961).

An outline is given of the theory which underlies the concept of the polarization of an electronic transition. Nuclear coordinate dependent electronic functions are employed to bring out the significance of "mixed polarization" in an electronic absorption or emission band. Brief attention is given to various techniques for obtaining polarizations of transitions. A detailed discussion is reserved for the method here called photoselection. This method includes, for example, polarized emission studies and polarized photochemistry. The theory underlying the method is outlined and critically discussed. A table of ideal orientation ratios for a variety of conditions is presented. Practical application of the theory is examined and it is shown how (and under what conditions) it is possible to relate gross observations to intrinsic molecular anisotropy of absorption (or emission). Two specific examples are analysed, one involving polarized emission, the other polarized photochemistry. Finally, it is shown how when polarization of phosphorescence and fluorescence measurements are made together, additional information can be provided with regard to anisotropy in absorption which is not available when only one of the two types of measurements is made. Comments regarding the variety of applications of photoselection are offered.

17332 USE OF DISTORTED ORBITALS IN MOLECULAR WAVE FUNCTIONS. R.L.Miller and P.G.Lykos.
J. chem. Phys. (USA), Vol. 35, No. 3, 1147-8 (Sept., 1961).

Gives calculated energies resulting from using three-parameter atomic orbitals for the $^2\Sigma_g^+$ and $^2\Pi_u$ states of H_2^+. Two of the parameters are the coefficients in a linear combination of three Slater orbitals of different symmetries and the third is their common exponent. The results are encouraging. J.Hawgood

17333 NATURE OF THE METAL-LIGAND BOND IN SOME COMPLEX CYANIDES FROM A STUDY OF RAMAN INTENSITIES. G.W.Chantry and R.A.Plane.
J. chem. Phys. (USA), Vol. 35, No. 3, 1027-31 (Sept., 1961).

A study of the Raman spectra of solutions of $[Zn(CN)_4]^{2-}$, $[Cd(CN)_4]^{2-}$, $[Hg(CN)_4]^{2-}$, $[Co(CN)_6]^{3-}$, $[Cu(CN)_4]^{3-}$, $[Ag(CN)_4]^{3-}$, and $[Fe(CN)_6]^{4-}$ shows that these complex ions fall into two distinct sets. For the first set, consisting of the first four species, the A_1CN frequencies are 2143, 2145, 2148, and 2152 cm^{-1} and the $\bar{\alpha}_{CN'}$ lie intermediate between those determined for free CN^- and CH_3CN. For the latter three species, the corresponding frequencies are 2094, 2097, and 2094 cm^{-1}. Furthermore, members of the latter set have abnormally large Raman intensities, i.e., large $\bar{\alpha}_{CN'}$, and an additional ultraviolet absorption band at 2600 A. For the first group, the assumption of partial sigma bonding of metal to C, consistent with the principle of essential electroneutrality, explains both the observed force constants and the values of $\bar{\alpha}_{CN'}$. The low intensity found for the ν_3 mode is explained in terms of the effect on this quantity of the large amount of s character in the carbon sigma orbital. The second group cannot be simply treated and appears to present an example of the breakdown of bond localized polarizabilities.

17334 VIBRONIC COUPLING. I. MATHEMATICAL TREATMENT FOR TWO ELECTRONIC STATES.
R.L.Fulton and M.Gouterman.
J. chem. Phys. (USA), Vol. 35, No. 3, 1059-71 (Sept., 1961).

A general mathematical treatment of vibronic coupling of two electronic states in molecules and dimers is presented. The 2×2 matrix Hamiltonian which is derived is shown to reduce to two one-dimensional Hamiltonians provided a certain minimum amount of symmetry is present. Some general selection rules governing electronic transitions to these states from the ground state are obtained, showing that the spectral distribution in hot bands may differ considerably from that in normal bands when vibronic coupling occurs. A special model which considers the coupling to arise f a single mode of vibration is presented. Two limiting cases whi can be treated approximately by perturbation theory are conside in detail. These are shown to give rise to a "pseudo Jahn–Telle effect" and to vibrational borrowing in the two different limits.

17335 MOLECULAR ORBITALS IN SOME BORON COMPOUNDS.
E.B.Moore, Jr, L.L.Lohr, Jr and W.N.Lipscomb.
J. chem. Phys. (USA), Vol. 35, No. 4, 1329-34 (Oct., 1961).

An LCAO treatment of boron framework orbitals in $B_{10}H_{14}$ yields a charge distribution of +0.05e on atoms 1 and 3, of −0.25 atoms 2 and 4, of −0.03e on atoms on 5, 7, 8, and 10, and of +0.27e atoms 6 and 9. When a charge of about −0.2e is assigned to each bridge H atom, the order of reactivity agrees with that expected from the chemical behaviour (neg 2,4 < 1,3 < 5, 7, 8, 10 < 6,9 p An LCAO investigation of boron orbitals in the B_5H_5 molecule of symmetry and with nine equal B–B distances indicates expected stability for the $(B_5H_5)^{2-}$ ion, but not for the neutral molecule. A simplified method of accounting for the molecular orbitals in ico hedral $(B_{12}H_{12})^{2-}$ yields some conclusions concerning B_{11} hydride and ions.

17336 THE BINDING ENERGY OF THE σ BOND. III. DISCU ON THE IONIC STRUCTURES. K.O-ohata.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1449-55 (Aug., 1960).

For Pt II see Abstr. 9964 of 1961. The ionic terms of the σ bonds are explicitly considered by the use of the semi-localize orbitals, and their contribution to the binding energy of the bond is discussed. A theoretical basis for the relation between Pauling's scale of electronegativity and Mulliken's [J. chim. Phy (France), Vol. 46, 497, 675 (1946)] is given under some assumpt The value of the binding energy of the C–C bond in the diamond crystal is computed to be 3.64 eV per bond, if the ionic terms of the bond are included. It is shown that the value of the binding energy of the diamond crystal in the Heitler–London approxima is almost equal to that in the molecular orbital method and less the above value by about 0.4 eV per bond. The resultant state, however, is found to be rather well expressed by the Heitler–London approximation.

17337 THE BINDING ENERGY OF THE σ BOND. IV. DISCUSSION ON THE HIGHER ORDER TERMS.
K.O-ohata.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1632-7 (Sept., 1960).

It is shown in the previous paper that the bond orbital meth gives the total energy of the molecule as the expanded power se of the overlap integrals between the bond orbitals. It is here shown that the contribution of the third order terms of these overlap integrals, which are neglected hitherto, to the binding energy of the σ bond is by no means negligible though smaller t that of the second order terms. In the case where the third ord terms are taken into account, the validity of the additivity rule the binding energies of the saturated hydrocarbons is discussed.

17338 DISPERSION FORMULA FOR THE ELECTRON IN A POTENTIAL BOX OF FINITE DEPTH AND THE OPTICAL POLARIZABILITY OF MOLECULES.
M.N.Adamov, V.K.Kagan and B.I.Orlov.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 276-9 (Feb., 1961). In Russian.

The extension of the calculation of optical polarizability of electron in a one-dimensional potential box to the case where th box is not infinitely deep (Abstr. 9800 of 1957; 17770 of 1960) is simplified by considering separately the states of different sym metry with respect to the reflection of the electron coordinate a the centre of the bottom of the box. Dispersion formulae are de rived for symmetric and antisymmetric states, and the static pola ability is calculated independently for the same states. The dep the box substantially affects the polarizability. The model is br applied to the longitudinal polarizability of the π-electrons in bu diene. [English translation in: Optics and Spectrosc. (USA), Vo No. 2, 139-40 (Feb., 1961)]. J.Sher

17339 MULTIPLE QUANTUM TRANSITIONS. P.Jung.
Physica (Netherlands), Vol. 27, No. 7, 707-9 (July, 1961).

It is shown that Bloch's phenomenological theory, as used i Abstr. 16179 of 1960, leads to the same expressions as the theo multiple quantum transitions (Abstr. 7660 of 1954; and 16181 of A double-quantum transition is shown experimentally in the cas

:on spin resonance for a radical, with an additional r.f. field
lel to the constant field. J.Hawgood

17340 ELECTRON SPIN RESONANCE SPECTRA OF FREE-RADICAL INTERMEDIATES FORMED BY REACTION 'OLYSTYRENE WITH ATOMS OF HYDROGEN AND TERIUM. R.B.Ingalls and L.A.Wall.
em. Phys. (USA), Vol. 35, No. 1, 370-1 (July, 1961).
A method is described for obtaining a concentration of inter- ates in a microwave cavity, sufficient for the observation of tra: the freeze-drying of benzene solutions of polystyrene and other polymers produced finely divided fluffy materials which itted the passage through them of a stream of hydrogen atoms nolecules. Possible mechanisms of the hydrogen–polystyrene tion are briefly discussed with reference to the spectra ned. E.F.W.Seymour

17341 CALCULATION OF THE ELECTRON SPIN RESONANCE LINE SHAPE FOR A POLYCRYSTALLINE RADICAL H ANISOTROPIC g TENSOR AND PROTON HYPERFINE RACTIONS. R.Lefebvre.
hem. Phys., (USA), Vol. 35, No. 2, 762-3 (Aug., 1961).
Calculations of the line shape of a CH π-electron radical with al values of electron–proton coupling constants and g-factor otropics show a magnetic field-dependent structure, provided superimposed component spectra consists of sufficiently narrow s. The calculated line shape for the carboxyhydroxymethyl cal is in good agreement with that obtained experimentally rant, Ward and Whiffen [Journal of the Chemical Society (GB), (1958)]. C.J.Ultee

17342 ELECTRON SPIN RESONANCE ABSORPTION OF TRIS-P-NITROPHENYLMETHYL. M.T.Jones.
hem. Phys. (USA), Vol. 35, No. 3, 1146 (Sept., 1961).
Large fractions of the theoretically possible numbers of rfine lines due to hydrogen nuclei and either N^{14} or N^{15} nuclei resolved in the spectrum of this radical in dilute solution in dimethoxyethane. Values of the hyperfine coupling constants assigned. E.F.W.Seymour

17343 AN E.P.R. STUDY OF THE TETRAFLUORO-HYDRAZINE–DIFLUORAMINO EQUILIBRIUM.
.Piette, F.A.Johnson, K.A.Booman and C.B.Colburn.
hem. Phys. (USA), Vol. 35, No. 4, 1481-2 (Oct., 1961).
The EPR spectrum of the difluoramino radical (NF_2) was ob- ed to be a single broad line at a pressure of 20-40 mm of N_2F_4 a temperature of 340°-435°K. The peak-to-peak linewidth was rved to be 104 gauss with a g value of 2.010. From the tem- ture dependence of the line amplitude, the ΔH of dissociation of was calculated to be 19.3 ± 1.0.

17344 THEORETICAL INTERPRETATION OF CARBON-13 HYPERFINE INTERACTIONS IN ELECTRON SPIN ONANCE SPECTRA. M.Karplus and G.K.Fraenkel.
hem. Phys. (USA), Vol. 35, No. 4, 1312-23 (Oct., 1961).
A quantitative theory of the isotropic electron-nuclear spin ractions of carbon 13 in pi-electron radicals is presented and lied to the hyperfine splittings observed in the electron spin onance spectra of these substances. The splittings arise from ma-pi interactions which polarize both the 1s and 2s electrons. 1s-orbital spin polarization is shown to contribute a term of ative sign with a magnitude comparable to that from the 2s elec- ns. For an sp^2 hybridized carbon atom that is bonded to three ns, X_i (i = 1, 2, 3), the hyperfine constants a^C has the form

$$a^C = (S^C + \sum_{i=1}^{3} Q_{CX_i}{}^C)\rho^\pi + \sum_{i=1}^{3} Q_{X_iC}{}^C \rho_i^\pi ,$$

re ρ^π and ρ_i^π (i = 1, 2, 3) are the pi-electron spin densities on ms C and X_i, respectively. The contribution of the 1s electrons letermined by S^C and that of the 2s electrons by the Q's, where Q^A is the sigma-pi parameter for the nucleus of atom A result- from the interaction between the bond BC and the pi-electron n density on atom B. Calculations for a planar CHC_2 fragment del yield S^C = −12.7 gauss, $Q_{CH}{}^C$ = 19.5 gauss, $Q_{CC'}{}^C$ = 14.4 gauss, $Q_{C'C}{}^C$ = −13.9 gauss. The theory predicts both the magnitude sign of the hyperfine splittings and is readily applied to a variety compounds. Excellent agreement is obtained with the available erimental data. For the methyl radical, the measured C^{13} itting is shown to be consistent with a planar model and limits the iation from planarity to <~ 5°. The theory provides a useful criterion for the validity of approximate wave-functions that is illustrated by a comparison of various theoretical treatments for the naphthalene negative ion and triphenylmethyl. The sigma-pi interaction parameters are shown to depend on the bond length, the type of hybridization (including the angles between sigma bonds), and on the nature of the bonding atoms. For pi-electron systems, the results demonstrate that the magnitude of the sigma-pi exchange energy is a small fraction of the total energy. It is also noted that the proton parameter $Q_{CH}H$ is somewhat larger in CHC_2 than in CH_3, which suggests a theoretical justification for some of the variation in the experimental "$Q_{CH}H$" required to fit measured proton splittings. The form of the theory is readily extended to the treatment of hyperfine splittings from nuclei other than C^{13}.

17345 ON THE C^{13} HYPERFINE STRUCTURE IN THE E.S.R. SPECTRUM OF THE NAPHTHALENE NEGATIVE ION FOR NATURAL ABUNDANCE. K.Markau and W.Maier.
Z. Naturforsch (Germany), Vol. 16a, No. 6, 636-8 (June, 1961). In German.
Reports a study of the C^{13} doublets in the hyperfine splitting spectrum of the naphthalene negative ion produced by reduction by sodium and potassium in tetrahydrofuran at concentrations below 10^{-3} M and at 3 cm. The C^{13} hyperfine splitting for all three carbons was determined. The spin densities on the carbons are estimated and seem to agree with values from the proton hyperfine splittings. J.G.Powles

HYPERFINE SPIN RESONANCE SPECTRUM OF THE BIPHENYL NEGATIVE ION IN SOLUTION. See Abstr. 15906

DYNAMIC NUCLEAR POLARIZATION IN DPPH. See Abstr. 14818

17346 THE CALCULATION OF C^{13}–H AND H–H' NUCLEAR SPIN COUPLING CONSTANTS OF ETHANE AND ETHYLENE USING VALENCE BOND WAVE-FUNCTIONS. J.Ranft.
Ann. Phys. (Germany), Vol. 8, No. 5-6, 322-8 (1961). In German.
The proton–proton and C^{13}–proton indirect spin coupling constants were calculated for ethane and ethylene type molecules using the method of Karplus, involving corrected valence bond wave-functions. The proton–proton constants show the correct behaviour with the polarity of the bond. The C^{13}–proton coupling constants, separated by a carbon atom, give values in agreement with experiment, i.e. about 5 c/s. J.G.Powles

17347 CONSTANCY OF THE SUMS OF SPIN–SPIN COUPLING CONSTANTS IN MONOSUBSTITUTED ETHYLENES.
G.S.Reddy and J.H.Goldstein.
J. chem. Phys. (USA), Vol. 35, No. 1, 380 (July, 1961).
It is pointed out that the sums of the three coupling constants for a wide variety of substituents fall into two or three well-defined groups. E.F.W.Seymour

17348 B^{11} QUADRUPOLE COUPLING CONSTANTS IN TRIMETHOXYBOROXINE AND N-TRIMETHYLBORAZOLE. M.A.Ring and W.S.Koski.
J. chem. Phys. (USA), Vol. 35, No. 1, 381-2 (July, 1961).
The coupling constants for the respective molecules were found from the splitting of the B^{11} nuclear magnetic resonance lines to be 2.14 ± 0.05 Mc/s and about 1.71 Mc/s. By comparison with the coupling constant for a single p electron it was deduced that there is 60% double-bond character in trimethoxyboroxine and 68% in N-trimethylborazole. E.F.W.Seymour

17349 ON THE MECHANISM OF NUCLEAR RELAXATION IN GASEOUS AND LIQUID CHF_3.
C.S.Johnson, Jr, J.S.Waugh and J.N.Pinkerton.
J. chem. Phys. (USA), Vol. 35, No. 3, 1128-9 (Sept., 1961).
The ratio of spin–lattice relaxation times for H^1 and F^{19} nuclei in fluoroform is about 2 in the liquid phase and greater than 100 in the gaseous phase. Detailed arguments are given to show that this is because a spin–rotational interaction is important for F^{19} but not for H^1. E.F.W.Seymour

17350 THEORY OF THE VARIATION OF THE NUCLEAR QUADRUPOLE INTERACTION IN COVALENT BONDS WITH APPLIED ELECTRIC FIELD. N.Bloembergen.
J. chem. Phys. (USA), Vol. 35, No. 3, 1131-2 (Sept., 1961).
A theory of the shift in the pure quadrupole resonance frequency with applied electric field for covalent bonds is presented. A linear effect is predicted for nuclei not at a centre of symmetry. The specific case of the Cl resonance in p-dichlorobenzene is discussed

in detail. The electric field frequency shift is caused by changes in sp hybridization, ionic character and length of the bond, which are calculated by the Ritz procedure. The predicted shift is 870 c/s for an external field along C–Cl of 10^4 V/cm^{-1}. See following abstract. J.G.Powles

17351 LINEAR EFFECT OF ELECTRIC FIELD ON THE Cl^{35} QUADRUPOLE INTERACTION IN PARADICHLOROBENZENE. J.Armstrong, N.Bloembergen and D.Gill.
J. chem. Phys. (USA), Vol. 35, No. 3, 1132-3 (Sept., 1961).

Observations of the broadening of the Cl^{35} pure quadrupole resonance in polycrystalline p-dichlorobenzene in fields up to 23.8 kV/cm at 77°K. A linear relation between second moment and field squared is observed corresponding to 590 ± 60 c/s (see preceding abstract). This is three times as large as in (ionic) sodium chloride. This Stark effect may give additional information about chemical bonds. J.G.Powles

17352 THE CALCULATION OF SECOND MOMENTS OF NUCLEAR MAGNETIC RESONANCE LINES FOR LARGE MOLECULES. ADAMANTANE MOLECULE. G.W.Smith.
J. chem. Phys. (USA), Vol. 35, No. 3, 1134-5 (Sept., 1961).

An error was detected in the computation by McCall and Douglass (Abstr. 16192 of 1960) of the rigid lattice second moment for protons in $C_{10}H_{16}$. A new calculation gives a value of 22.40 g^2 in fair agreement with recent unpublished measurements. E.F.W.Seymour

17353 LONG-RANGE NUCLEAR MAGNETIC SHIELDING IN MOLECULES AND THE ANISOTROPY IN THE MAGNETIC SUSCEPTIBILITY OF A CARBON–CARBON SINGLE BOND. J.I.Musher.
J. chem. Phys. (USA), Vol. 35, No. 4, 1159-69 (Oct., 1961).

A method is discussed for obtaining quantitative measurements of long-range NMR shielding effects in molecules based on the theory of Ramsey as extended by McConnell. These effects are shown to arise principally from the diamagnetic part of the magnetic susceptibility of the individual bonds when the origin of coordinates is taken at the geometric centre of the bond. Application is made to saturated hydrocarbon alcohols for which the only long-range shielding contributions come from tetrahedral carbon-carbon bonds. From high-resolution NMR measurements of tertiary protons on carbocyclic molecules the existence of these effects is verified and the magnitude of the magnetic anisotropy on the individual bonds causing such effects is determined.

17354 TEMPERATURE-DEPENDENT CHEMICAL SHIFTS IN THE N.M.R. SPECTRA OF GASES.
L.Petrakis and C.H.Sederholm.
J. chem. Phys. (USA), Vol. 35, No. 4, 1174-8 (Oct., 1961).

It was found that the chemical shifts of various gaseous compounds, using gaseous methane as a standard, vary with temperature. The slopes of chemical shift versus temperature at 50°C are tabulated for several compounds. This effect is ascribed to excitation of vibrational modes of the molecules, the protons in the excited molecules being differently shielded compared with the protons in the ground vibrational states. The data are interpreted to yield approximate chemical shifts associated with the excitation of various types of modes. NMR isotopic shifts are discussed on the basis of these data.

17355 N.M.R.FLUORINE–FLUORINE COUPLING CONSTANTS IN SATURATED ORGANIC COMPOUNDS.
L.Petrakis and C.H.Sederholm.
J. chem. Phys. (USA), Vol. 35, No. 4, 1243-8 (Oct., 1961).

The spectra of several fluorine-substituted, saturated organic compounds were investigated. It was found that the coupling constants between 1,2 fluorine atoms are usually near zero. The coupling constants between 1,3 fluorine atoms in a free chain are usually between 7 and 10 c/s if all of the intermediate skeletal atoms are carbon atoms. If one of the intermediate skeletal atoms is a nitrogen atom, these coupling constants go up to between 10 and 17 c/s. The coupling constants between 1,4 fluorine atoms are usually in the range 2-7 c/s when a nitrogen atom is in the intermediate skeletal chain. Rings usually reduce all coupling constants below the above stated values. Several exceptions are found to these generalizations. These generalizations with their exceptions lead the authors to believe that in the case of coupling between fluorine atoms, the main effect is not through-the-bonds, but rather a direct-through-space interaction. It is demonstrated that the restricted rotation about the carbon–carbon bonds has little to do with the near-zero coupling constants, but that these are readily explained on the basis of through-space coupling.

17356 VIBRATIONAL EFFECT ON THE NUCLEAR QUADRUPOLE COUPLING IN ND_3. Y.Kato.
J. Phys. Soc. Japan, Vol. 16, No. 1, 122 (Jan., 1961).

The nuclear quadrupole coupling constant eqQ at the positio of the N^{14} nucleus in NH_3 and ND_3 is -4.10 Mc/s and -4.0842 Mc, respectively. Calculations were made of the nuclear quadrupole moment $Q(N^{14})$ and the electric field strength gradient in ND_3, assuming that the nuclear contribution to q predominates, and thereby deriving a vibrational average. The excellent agreemen between theory and experiment confirms the validity of the assumptions that nuclear contributions to q are dominant, and o the vibrational averaging procedures. R.W.Nich

17357 THE NUCLEAR MAGNETIC RESONANCE SPECTRA FOUR SPIN SYSTEMS. I. THE H^1 AND F^{19} RESONA SPECTRA OF 1-FLUORO, 2, 4-DINITROBENZENE.
B.D.Nageswara Rao and P.Venkateswarlu.
Proc. Indian Acad. Sci. A, Vol. 52, No. 3, 109-21 (Sept., 1960).

High resolution H^1 and F^{19} n.m.r. spectra of 1-fluoro, 2, 4-dinitrobenzene were obtained and analysed to determine all the parameters involved. As the spectrum of one of the protons is separated from that of the other two, the secular equation was solved in the first approximation. The analysis gives the follow spin–spin coupling constants: $J_o(HH) = 8.7 \pm 0.3$ c/s, $J_m(HH) = 2.9 \pm 0.2$ c/s, $J_p(HH) = 0.6 \pm 0.3$ c/s, $J_o(HF) = 10.4 \pm$ ± 0.2 c/s, and the two meta H–F coupling constants were found be considerably different, being 6.5 ± 0.3 c/s and 3.8 ± 0.3 c/s. was found that the ortho and meta H–F coupling constants have same sign as the ortho and para H–H coupling constants.

NUCLEAR MAGNETIC RESONANCE SPECTRA OF SEVERA OLEFINIC COMPOUNDS. See Abstr. 15911

17358 DYNAMIC POLARIZATION ANOMALIES IN ORGAN FREE RADICALS. R.H.Webb.
Phys. Rev. Letters (USA), Vol. 6, No. 11, 611-13 (June 1, 1961).

Wurster's blue perchlorate exhibited an Overhauser enhanc ment of the proton magnetic resonance above 77°K, but a "solid state" enhancement at 4.2°K. A similar change occurred in 1-3-bis-diphenylene-2-phenyl allyl at about 1.4°K. Picryl amin carbazyl showed both effects above 77°K but the solid-state effe alone at 4.2°K. The appearance of the solid-state effect correl in all the cases with the appearance of g = 4 satellite lines in th electron spin resonance spectra. E.F.W.Sey

17359 PROTON RESONANCE INVESTIGATION FOR THE DETERMINATION OF THE INTRAMOLECULAR HINDERING POTENTIAL IN CYCLIC PEROXIDES.
H.Friebolin and W.Maier.
Z. Naturforsch. (Germany), Vol. 16a, No. 6, 640 (June, 1961).
In German.

The methyl proton signal at 60 Mc/s for 3, 3, 6, 6-tetratet 2-dioxa-cyclohexane in methylene chloride is split into two line (11 c/s) below -20°C and changes into one line with rising tempe ture. This is interpreted as the effect of chain–chain conversi exchanging axial and equatorial methyl groups with an energy barrier of 11.7 kcal/mole. No splitting was observed in the met signal for 3,3,5,5-tetramethyl-1,2-dioxa-cyclopentane down to -40°C and the barrier here is assumed to be lower. J.G.Po

17360 NOTE ON THE STATISTICAL THEORY OF MASS SPECTRA. J.C.Schug and N.D.Coggeshall.
J. chem. Phys. (USA), Vol. 35, No. 3, 1146-7 (Sept., 1961).

When a molecule is considered as a collection of oscillator the state density functions become $k_i = \nu_i (1 - \epsilon_i/E)^S$ where ν_i i frequency factor, ϵ_i the activation energy for dissociation, E th excess energy of a decaying ion, and s the number of vibrationa degrees of freedom in the activated complex. The relative abun ances of the several ions relative to $C_6H_{13}^+$ in the low voltage m spectrometer pattern of n-octane are calculated using s, E and ν_i/ν_j as adjustable parameters. The values of s which it is necessary to use are very small, of the order of 1/100 of those expected. This suggests that this theory cannot be applied to lo voltage spectra. T.E.Pea

17361 MASS SPECTROMETRIC STUDY OF THE THERMA DISSOCIATION OF N_2F_4. J.T.Herron and V.H.Dibe
J. chem. Phys. (USA), Vol. 35, No. 2, 747-8 (Aug., 1961).

The NF_2^+ and $N_2F_4^+$ ion currents were measured after equili at each selected temperature between 330° and 673°K. The rati $NF_2^+/N_2F_4^+$ at 330°K was taken as characteristic of the normal m

rum of N_2F_4. From its value and the measured $N_2F_4^+$ ion current quilibrium constant was obtained, the variation of which with erature and the usual application of the Van't Hoff isochore ed a value for the enthalpy of the reaction equal to ± 1.6 kcal/mole. From this dissociation energy the thermo- ical constants of several N-F compounds are calculated. A arison is made of the bond dissociation energies in the mole- NF$_3$ and NH$_3$. W.Good

17362 MECHANISM OF DISPROPORTIONATION IN ALKYL RADICAL REACTIONS. J.N.Bradley.
em. Phys. (USA), Vol. 35, No. 2, 748-50 (Aug., 1961).
It is argued that rearrangement of the activated molecule to give oportionation products is possible after passage through the ition state. In the reaction $C_2H_5 + C_2H_5$ the rearrangement must eed via a highly active butane molecule, in which the equences of violent bending motions are considered. Evidence ted in support of such a mechanism. W.Good

17363 SPATIAL DISTRIBUTION OF FREE RADICALS AS STUDIED BY ELECTRON SPIN RESONANCE.
Smith and S.J.Wyard.
re (GB), Vol. 191, 897-8 (Aug. 26, 1961).
The distribution of free radicals of H_2O_2 in H_2O and of D_2O_2 in in irradiated glasses at 90°K was measured by electron spin nance spectroscopy. The local radical concentrations and esponding average separations produced by different types of ation are given. G.I.W.Llewelyn

17364 ANTIFERROMAGNETIC TO FERROMAGNETIC TRANSITIONS IN ORGANIC FREE RADICALS.
Edelstein and M.Mandel.
hem. Phys. (USA), Vol. 35, No. 3, 1130-1 (Sept., 1961).
The magnetic susceptibilities of picryl amino carbazyl and ster's blue perchlorate were found, apart from a constant factor, the intensities and widths of the electron spin resonance lines. room temperature, the susceptibilities fitted a Curie—Weiss with large negative values of θ; in the He temperature range the e law held with small positive values of θ. E.F.W.Seymour

FREE RADICALS TRAPPED IN γ-IRRADIATED POLY- IYLENE. See Abstr. 14344

17365 DISSOCIATION ENERGIES OF THE GASEOUS MONO- HALIDES OF BORON, ALUMINIUM, GALLIUM, UM AND THALLIUM. R.F.Barrow.
ns Faraday Soc. (GB), Vol. 56, Pt 7, 952-8 (July, 1960).
Thermochemical and spectroscopic evidence about the group of le molecules from BF to TlI is considered, and values of the ociation energy are proposed.

17366 THEORY OF MOLECULAR DISSOCIATION INDUCED BY NEUTRONS. I. DIATOMIC MOLECULES.
S.Sayasov and G.K.Ivanov.
eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 513-23 (Feb., 1961).
ussian.
A theory based on the Fermi pseudopotential method is developed the dissociation of diatomic molecules. It is assumed that the ron energy is of the order of the dissociation energy, and that ng disintegration the molecule remains in the ground electron e. Under these assumptions, simple final formulae can be ined for the cross-sections of the processes. [English trans- on in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 360-6 ., 1961)].

DISSOCIATION OF TlBr MOLECULES. See Abstr. 15959

17367 MEASUREMENT OF MOLECULAR DIAMETERS AND AVERAGE VELOCITIES. R.E.Warner.
er. J. Phys., Vol. 29, No. 11, 736-8 (Nov., 1961).
Pumping speed and gas viscosity measurements are described. se experiments permit a determination of average molecular ocities and molecular diameters to better than 10% accuracy. acuum pump, two McLeod gauges, and a filar micrometer roscope are required.

17368 ROTATIONAL ISOMERISM IN TEREPHTHALDEHYDE ANION. A.H.Maki.
hem. Phys. (USA), Vol. 35, No. 2, 761-2 (Aug., 1961).
The ESR spectra observed at 9.7 kMc/s shows the existence of isomers A and B. Three proton coupling constants are required ssign each resonance. For A: a = 2.08, b = 0.70 and c = 3.89; B: a = 1.16, b =1.54 and c = 3.81 all ±0.01 G. The observed population ratio at 20° C is $P_A/P_B = 1.40 \pm .06$ leading to $\Delta F^0_{293} = 200 \pm 25$ cal mole^{-1} for the A → B conversion. Preliminary calculations indicate that A and B are the cis and trans isomers respectively. C.J.Ultee

17369 ROTATIONAL ISOMERISM IN 2, 3 DIHALOPROPENES. E.B.Whipple.
J. chem. Phys. (USA), Vol. 35, No. 3, 1039-44 (Sept., 1961).
Previously reported variations in different solvents of the long-range (1, 3) n.m.r. coupling constants in 2, 3 dihalopropenes have suggested the existence of rotational isomers in rapid equilibrium. This view is supported by infrared spectra. By assuming an angular dependence of the form $J = J_0 \cos^2\phi$ between the observed coupling constants and the dihedral angle of the methylene C—H bonds as suggested in calculations by Karplus, the identities of the isomers are deduced, the equilibrium constants calculated, and the energy differences expressed as a function of solvent dielectric constant using an Onsager cavity model. The results for 2, 3 dichloropropene are compared with published dipole moment measurements in solution and in the vapour at elevated temperatures.

17370 MEAN AND EQUILIBRIUM MOLECULAR STRUCTURES OF METHANE AND DEUTEROMETHANE AS DETERMINED BY ELECTRON DIFFRACTION.
L.S.Bartell, K.Kuchitsu and R.J.deNeui.
J. chem. Phys. (USA), Vol. 35, No. 4, 1211-18 (Oct., 1961).
The structural parameters of methane and methane-d were determined with the new rotating-sector electron diffraction apparatus of Iowa State University. The results demonstrated, for the first time by electron diffraction, the existence of isotope effects on structure. Mean internuclear distances were C—H = $1.106_8 \pm 0.001$ A, C—D = $1.102_7 \pm 0.001$ A, H ··· H - 1.811 ± 0.007 A, and D ··· D = = 1.805 ± 0.008 A. Mean amplitudes, reckoned from mean positions, were C—H = $0.075_1 \pm 0.002$ A, C—D = $0.066_3 \pm 0.002$ A, H ··· H = = 0.120 ± 0.006 A, and D ··· D = 0.105 ± 0.006 A. The isotope effects were just those expected for atoms of different mass vibrating in identical anharmonic force fields. Vibrational anharmonicity led to measurable phase shifts in the molecular diffraction patterns from which the asymmetry of the internuclear distribution functions could be determined. This allowed a direct experimental determination of the approximate equilibrium C—H and C—D bond lengths, giving 1.08_8 A. Somewhat more rigorous calculations of the correction from mean to equilibrium distances based on anharmonic Urey—Bradley field led to equilibrium C—H and C—D bond lengths of 1.08_4 A and 1.086_3 A, respectively. Corresponding equilibrium bond lengths computed from the spectroscopic r values of 1.094_0 A and 1.902_3 A, respectively, were 1.085_0 A and 1.085_6 A. The comparison clearly illustrates the appreciable difference between electron diffraction and spectroscopic methods in the manner averaging over molecular motions, but also confirms the essential equivalence of molecular information derived, if suitable corrections are applied to each.

17371 MOLECULAR STRUCTURE OF PROPYLENE. D.R.Lide, Jr and D.Christensen.
J. chem. Phys. (USA), Vol. 35, No. 4, 1374-8 (Oct., 1961).
The microwave spectra of seven isotropic species of propylene were studied in order to obtain an accurate molecular structure. The complete r_S (substitution) structure has been calculated. The more important parameters are: r(C=C) = 1.336 ± 0.004 A, r(C—C) = 1.501 ± 0.004 A, ∠ CCC = 124.3° ± 0.3°. The structure is compared with those of related molecules. It is concluded that no difference can be detected in the double-bond lengths in ethylene, propylene, and the vinyl halides. The CC single-bond length in propylene is indistinguishable from that in acetaldehyde and other acetyl compounds, and is 0.025 A shorter than the CC distance in saturated hydrocarbons. In the $=CH_2$ group in propylene, the CH bond trans to the methyl group appears slightly shorter than the cis CH bond; a similar effect occurs in the vinyl halides.

17372 THE MOLECULAR STRUCTURE OF BIS (N,N-DI- ETHYLDITHIOCARBAMATE)-NICKEL (II).
A.Vaciago, A.Cabrini and C.Mariani.
Ricerca sci. (Italy), Vol. 30, No. 12, 2519-27 (Suppl. Dec., 1960).
In Italian.
After discussing the possible relationships between the structure and properties of some complex salts of dithiocarbamic acid, the first results of the crystallographic determination of the molecular structure of bis (N,N-Diethyldithiocarbamate)-Nickel (II) are presented. They refer to the projection normal to the [100] axis: this projection is completely resolved and R(Okl) = 0.184.

CONFIGURATION AND DIPOLE MOMENTS OF ANILINE AND ITS DERIVATIVES. See Abstr. 15895

BIBLIOGRAPHY ON MOLECULAR STRUCTURE MODELS. See Abstr. 15021

17373 DIPOLE MOMENT OF HD. II. S.M.Blinder.
J. chem. Phys. (USA), Vol. 35, No. 3, 974-81 (Sept., 1961).

For Pt. I, see Abstr. 4237 of 1960. The permanent electric dipole moment in the ground vibrational state of HD is computed by a variational technique (generalized perturbation method). Implicit account is thereby taken of contributions from higher molecular states of $^1\Sigma_u^+$ symmetry. The value $\langle\mu_z\rangle_{v=0}=5.67\times10^{-4}$ Debye unit is assigned. Factors affecting the accuracy of the computation are discussed in detail. It is shown that an effective dipole moment function may be defined despite the fact that the dipole arises from a vibrational-electronic interaction.

17374 THE APPLICATION OF ONSAGER'S THEORY TO DIELECTRIC DISPERSION — A CORRECTION. N.E.Hill.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 311-12 (Aug., 1961).

In a previous publication (Abstr. 1408 of 1959) was assumed that the reaction field produced by the permanent dipole moment remains parallel to the total momentum; the couple tending to turn the molecule was consequently calculated incorrectly. It is now shown that the Cole—Cole plot consists of an arc which lies slightly outside the Debye semicircle. J.H.Mason

17375 EFFECT OF AN ATTRACTIVE POTENTIAL ON THE CLASSICAL THEORY OF VIBRATIONAL ENERGY EXCHANGE. R.E.Turner and D.Rapp.
J. chem. Phys. (USA), Vol. 35, No. 3, 1076-7 (Sept., 1961).

The usual theory of vibrational energy transfer between molecules uses a purely repulsive exponential potential with an energy zero at the bottom of the van der Waals attractive potential well. One therefore uses a velocity distribution modified by a factor $\exp(\epsilon/kT)$ to take the attractive forces into account. This method is an artifice to avoid dealing with the detailed dynamics of motion in the attractive potential well. In the present paper, the complete dynamical problem for a "Morse"-type potential, consisting of an attractive term in addition to the exponential repulsion, is solved. A more rigorous correction for the attractive forces is proposed.

17376 ENERGY TRANSFER FROM THE TRIPLET STATE. G.Porter and F.Wilkinson.
Proc. Roy. Soc. A (GB), Vol. 264, 1-18 (Oct. 24, 1961).

Energy transfer from the triplet level of a donor molecule resulting in quenching of the donor and elevation of the acceptor molecule from its singlet ground state to a triplet state was observed between a number of donor—acceptor pairs in fluid solvents. In most cases the mechanism of the transfer was unequivocally established by observation of the triplet state absorption spectra of both species. Energy transfer from excited singlet donors to the triplet state of the acceptor was not observed. When the energy of the acceptor triplet is considerably lower than that of the donor, transfer is diffusion-controlled but there is no evidence for long-range resonance transfer of the kind found in the analogous singlet energy transfer processes. As the triplet energies become comparable the transfer probability is reduced and no quenching is observed by molecules with triplet levels higher than that of the donor. Transfer of triplet energy between pairs of aromatic hydrocarbons is illustrated and it is established that complex formation between donor and acceptor cannot be important under the conditions of these experiments.

17377 POTENTIAL CURVES OF DIATOMIC MOLECULES AND POTENTIAL ENERGY SURFACES OF POLYATOMIC MOLECULES FOR SMALL NUCLEAR SEPARATIONS. W.A.Bingel.
Z. Naturforsch. (Germany), Vol. 16a, No. 7, 668-75 (July, 1961). In German.

The expansion of the potential energy function of a molecule in powers of the distances R_α of the nuclei from the united atom (UA)

$$V = \sum\sum_{\alpha>\beta} Z_\alpha Z_\beta / R_{\alpha\beta} + W_u + \sum_\alpha (E_{2,\alpha}\cdot R_\alpha^2 + E_{2,\alpha}\cdot R_\alpha^3) + \ldots$$

is discussed in detail. It is shown to be valid for all states of diatomic and linear polyatomic molecules and for all those molecular states, which can be derived from UA-S-states, when the expressions given earlier for the coefficients $E_{2,\alpha}$ and $E_{3,\alpha}$ in terms of the electron density of the corresponding UA-state u are used. It is further shown that the same expansion can also be used for nonlinear polyatomic molecules with orbitally degenerate UA-states if linear combinations of the correct symmetry are used in the evaluation of $E_{2,\alpha}$ and $E_{3,\alpha}$. Finally, it is proved that for diatomic and linear polyatomic molecules the quadratic terms $E_{2,\alpha}\cdot R_\alpha^2$ are independent of the position of the united atom on the molecular axis.

17378 MOLECULAR COLLISIONS. III. SYMMETRIC TOP MOLECULES. G.Gioumousis.
J. math. Phys. (USA), Vol. 2, No. 5, 723-7 (Sept.-Oct., 1961).

For Pt II see Abstr. 4955 of 1961. The question of rotational energy transfer in molecular collisions is treated for the case of symmetric top molecules. The Schrödinger equation for this problem, which can be taken as an integral equation over nine variables, is reduced to a set of coupled one dimensional integral equations by means of expansions over the irreducible representations of the three-dimensional rotation group. Various selection rules are found, of which two, in indices (in the matrix elements of the potential) related to the quantum number k, have no counterpart in the previously developed theory for diatomic molecules. The results are exhibited as cross-sections for the excitation of rotational states given the states before the collision. The rotational states for the symmetric top rotors are specified by the usual quantum number k, l, m, and the translational states by the velocity and direction of motion. The angular dependence of the cross-section is treated by means of an expansion in spherical harmonics which is new in this context and which promises to be extremely useful in the application to transport processes.

17379 UNPERTURBED MEAN-SQUARE END-TO-END DISTANCE OF POLYETHYLENE. C.A.J.Hoeve.
J. chem. Phys. (USA), Vol. 35, No. 4, 1266-7 (Oct., 1961).

It is shown that previous methods for calculating the mean-square end-to-end distance $\langle r_o^2\rangle$ of polyethylene are invalid, since no account is taken of interactions between rotations around chain bonds. With the aid of recently developed matrix methods the value of $\langle r_o^2\rangle/nl^2$ is calculated to be 6.75 at 160°C in excellent agreement with the results deduced from intrinsic viscosity measurements.

17380 NORMAL VIBRATIONS OF THE POLYMER MOLECULES OF HELICAL CONFIGURATION. II. A SIMPLE METHOD OF FACTORING OF THE SECULAR EQUATION. H.Tadokoro.
J. chem. Phys. (USA), Vol. 35, No. 3, 1050-54 (Sept., 1961).

For Pt I, see Abstr. 20698 of 1960. A simple method of the factoring of the secular equation useful for helical polymer molecules under the factor group $D(2m\pi/n)$ was derived. This method is also applicable to the molecules under the point groups D_n, C_n and the groups which contain the subgroup D_n or C_{nv}. As an example the secular equation of the skeletal vibrations of the polyoxymethylene molecule was factored by this method.

17381 A CORRECTION TO MY PAPER "THE DIPOLE MOMENT AND END-TO-END LENGTH OF THE ISOTACTIC VINYL POLYMER. I." T.Mori.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2118 (Nov., 1960).

A claim in the first paper (Abstr. 12343 of 1961) is slightly modified in the light of a new result to be proved in a forthcoming paper. H.N.V.Temperley

17382 DETERMINATION OF THE EXTENSION OF LINEAR POLYMER MOLECULE IN THE SOLUTION BY THE LIGHT SCATTERING. Y.Miyake.
J. Phys. Soc. Japan, Vol. 16, No. 9, 1703-8 (Sept., 1961).

With use of Peterlin's and Mizutani's light scattering function $P(\theta)$ (Abstr. 1137, 3910 of 1956) a simple method was developed to determine the mean square end-to-end distance $\langle r^2\rangle$. Following Peterlin and Mizutani, $\langle r^2\rangle$ is assumed to be proportional to N^γ, where N is the degree of polymerization and γ is a parameter. Values obtained of $\langle r^2\rangle$ are $(5.53)^2\times10^{-16}N^{1.15}$, $(42.51)^2\times10^{-16}N$ and $(6.39)^2\times10^{-16}N^{1.11}$ for polystyrene in toluene, in methylethyl ketone and in cyclohexane solutions, respectively. These results suggest that the excluded volume of chain elements and the interaction between the polymer and the solvent are important factors in the determination of the extension of polymer molecules in both good and poor solvents. Brief discussions on the polydispersivity of the system are also given.

17383 FAST MOLECULAR NITROGEN BEAM. N.G.Utterback and G.H.Miller.
Rev. sci. Instrum. (USA), Vol. 32, No. 10, 1101-6 (Oct., 1961).

Apparatus was developed for producing a molecular N_2 beam

ing the energy range 5-1000 eV. The technique includes
tion by electron impact, acceleration and focusing, and
alization by charge transfer. Energy spread is 0.5 eV. The
intensity ranges from 10^8 molecules per sec at low energy to
t high energy. The absolute beam intensity can be determined
20%. Charge transfer efficiency, beam intensity monitoring,
daptability of the apparatus to the studies of ionization cross-
ns and surface phenomena are discussed.

17385 THE MEAN FREE PATH OF MOLECULES IN A MOLECULAR BEAM. V.S.Troitskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 389-90 (Aug., 1961). In Russian.

It is shown that the mean free path of a molecule at some given point in a molecular beam with a Maxwellian velocity distribution is almost exactly three times greater than the path length in a gas of the same density. [English translation in: Soviet Physics—JETP (USA)].

SOLID-STATE PHYSICS

385 CRITICAL PERCOLATION PROBABILITIES (SITE PROBLEM).
H. Frisch, E.Sonnenblick, V.A.Vyssotsky and J.M.Hammersley.
Phys. Rev. (USA), Vol. 124, No. 4, 1021-2 (Nov. 15, 1961).
See also Abstr. 12346 of 1961, on the bond problem. Monte
estimates of the critical percolation probabilities for the
"site problem" are presented for a number of two- and three-
dimensional crystal lattices. The connection with the critical
concentration of magnetic elements of certain models of random
magnetically dilute) ferromagnetic crystals is noted.

7386 A REMARK ON THE USE OF THE REPULSIVE POTENTIAL. E.Antončík.
Czech. J. Phys., Vol. 10, No. 10, 766-7 (1960).
Compares the use of the repulsive potential in the orthogonalized
wave method by Kleinman and Philips (Abstr. 1538 of 1960)
with that by the author (Abstr. 3915 of 1955; 2777-8, 13521 of 1960),
shows that some difficulties and inconsistencies in the former
are removed in the latter, where symmetry is preserved
throughout. J.Hawgood

IONIC STRUCTURE AND PHYSICAL PROPERTIES OF TiN.
See Abstr. 14870

387 THE ELECTROSTATIC FIELD IN METALS, IN PARTICULAR AT THE SURFACE NEXT TO A NON-CONDUCTOR. F.Ollendorff.
Arch. Elektrotech. (Germany), Vol. 46, No. 1, 1-26 (1961).
In German.

The author points out that in consequence of the macro-
differences of potential resulting from the triply periodic micro-
potential field of the lattice structure of rigid bodies, occurring
generally within one and the same conductor and observed as
contact potentials between contiguous conductors, the classical
result that there is no electrical field within a conductor is
unsatisfactory. The Fermi—Sommerfeld electron theory is proposed
as a basis of a satisfactory electrostatics of metals. The statistical
equilibrium of the free electron gas is interpreted as the mutual
attraction of a convection current due to the field and a diffusion
current due to the concentration gradient. The appropriate values
of the mobility and diffusion coefficient are given for the present
case of completely degenerate gases, and their quotient is
regarded as a substitute for the restricted Einstein relation for an
ideal gas. The combination of the Fermi—Sommerfeld electron
theory and Poissons equation leads to a nonlinear partial different-
ial equation of the second order for the macropotential. The
differential equation for the potential is integrated numerically,
three cases being distinguished; a surplus of electrons at the edge
of the electrode, a deficiency of electrons at the edge of the electrode
and a total absence of free electrons in a boundary region of finite
width. It is stated that a revision of the usual view of the work of
expelling free electrons is unavoidable and it is proposed to
distinguish within the metal between the spatial mean value of the
potential and its expected value resulting from the emission
probabilities of the electrons. The difference between these is
considered responsible for the work of emission. The existence
of a critical field strength which permits the passage of free
electrons into the surrounding vacuum is deduced. This "break
through" field strength, for which the field emission just
commences, agrees with that which causes significant emission
in the wave-mechanical tunnel-effect treatment of the same
problem. Conversely an electrostatic field is only realized in
a plane parallel system when the field strength remains less than
the break-through field strength. It is deduced that the capacity of
a plane parallel vacuum plate condenser is a function of the
electrode potentials which are nonlinearly related. J.Berry

MAGNETIC FIELD AT THE NUCLEUS IN SPINEL-TYPE CRYSTALS. See Abstr. 14745

LOCAL MAGNETIC FIELDS IN Fe—Al ALLOYS.
See Abstr. 14687

17388 CALCULATION OF THE PARAMETER D OF THE CRYSTALLINE FIELD IN LATTICES OF THE TYPE NaCl AND CsCl. R.Coelho.
J. Phys. Radium (France), Vol. 22, No. 2, 122-3 (Feb., 1961).
In French.

For a crystal with cubic symmetry (group Oh) it is usual to expand the crystal potential, V, about the centre of symmetry in the form:

$$V = A + D(x^4 + y^4 + z^4 - \tfrac{3}{5}(x^2 + y^2 + z^2)^2)$$

where A is the Madelung constant and $(x^2 + y^2 + z^2)^{1/2}$ is small compared with the interatomic spacing. This paper is concerned with the calculation of D for two particular configurations. A series expression is obtained for V, using a lattice of 48 sites, which converges sufficiently rapidly to allow a good approximation to the sum to be obtained. The results quoted are
NaCl lattice:

$$V = \frac{e}{R}^{*} [1.7475 + \frac{8.935}{R^4}(x^4 + y^4 + z^4 - \tfrac{3}{5}(x^2 + y^2 + z^2)^2)]$$

CaCl lattice:

$$V = \frac{e^*}{R}[1.7626 - \frac{6.55}{R^4}(x^4 + y^4 + z^4 - \tfrac{3}{5}(x^2 + y^2 + z^2)^2)]$$

where e* is the effective ionic charge and R the interatomic distance. It is noted that the 6 nearest neighbours in NaCl contribute 98% of D, whereas the 8 nearest neighbours of CsCl contribute only 76%. P.J.Dean

17389 CONTRIBUTION OF STRAIN TO NUCLEAR QUADRUPOLE INTERACTIONS IN DILUTE ALLOYS OF COPPER.
P.L.Sagalyn, A.Paskin and R.J.Harrison.
Phys. Rev. (USA), Vol. 124, No. 2, 428-37 (Oct. 15, 1961).

The hypothesis that electric field gradients due to elastic strains (size effect) about the solute atom in dilute alloys of a cubic metal form an important part of the total field gradient at the solvent nuclei is developed quantitatively. Results are applied to a consideration of recent nuclear magnetic resonance experiments by Rowland on dilute copper alloys (Abstr. 13890 of 1960) which were interpreted by him and by Kohn and Vosko (Abstr. 13891 of 1960) in terms of the spatially oscillating charge due to conduction electron redistribution (valence effect). The good agreement with theory they obtained is further improved to a significant degree by the simultaneous consideration of both size effect and valence effect. It is found that the field gradients due to size effect are in fact comparable in magnitude to those due to the valence effect. The magnitude of the size effect is described by a single parameter characteristic of the solvent. It is found that the value of this parameter obtained for

copper metal is larger than that indicated by recent experiments by Faulkner and by Averbuch et al. (Abstr. 4527 of 1960) and possible causes of this disagreement are discussed.

17390 PERIODIC POTENTIAL IN IONIC CRYSTALS. Y.Siota.
Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 3, 137-42 (Oct., 1959).

Fourtier coefficients of the periodic potential in various ionic crystals are calculated. The results are given in tabular form. The potential for three directions in a sylvine lattice is calculated as an application and shown in a diagram.

17391 INTERPRETATION OF THE ISOMERIC CHEMICAL SHIFTS IN Au^{197}. D.A.Shirley.
Phys. Rev. (USA), Vol. 124, No. 2, 354-8 (Oct. 15, 1961).

The large chemical shifts recently observed in Mössbauer absorption experiments on Au^{197} (Abstr. 11147 of 1961) are explained on the basis of Coulombic interaction between the 6s electron of gold and the $3s_{1/2}$ and $2d_{1/2}$ protons. A first-order perturbation calculation is made, using the Coulombic potential within the nucleus due to the 6s electron. Proton wave-functions derived from harmonic-oscillator, square-well, and Woods—Saxon nuclear potentials are treated. The latter two potentials yield results that are in reasonable accord with experiment. This model can afford a sensitive comparison of nuclear potentials as well as a determination of the s conduction-electron density on impurity atoms. In particular, this calculation discriminates against the harmonic-oscillator potential and shows that the 6s electron density on a gold impurity atom in several hosts is higher than in pure gold. These results also indicate that the $3s_{1/2}$ proton subshell is filled in the ground state of Au^{197}.

17392 GROUP THEORY OF SCATTERING PROCESSES IN CRYSTALS. R.J.Elliott and R.Loudon.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 146-51 (Aug., 1960).

A general method is given for determining selection rules for scattering of various types in crystals by using the properties of space groups. The method is particularly useful for those lattices which contain screw axes or glide planes and diamond is considered in detail. Examples of particular kinds of selection rule which are of interest in silicon and germanium are examined.

LATTICE MECHANICS

17393 SCATTERING OF γ-QUANTA BY NUCLEI OF SOLIDS. I.P.Dzyub and A.F.Lubchenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 8, 2275-84 (Aug., 1961). In Russian.

Discusses the resonant multiple scattering of γ-quanta by the nuclei of a crystal lattice. It is shown that a measurement of the spectrum of γ-quanta scattered at and near the Bragg-angle may determine the spectrum of normal modes of the scattering crystal. [English translation in: Soviet Physics—Solid State (USA)].

J.E.Paton

17394 EMISSION AND ABSORPTION OF GAMMA-RAYS WITHOUT RECOIL OF THE EMITTING NUCLEUS, HELD IN A CRYSTAL LATTICE (MÖSSBAUER EFFECT). E.Cotton.
J. Phys. Radium (France), Vol. 21, No. 5, 265-87 (May, 1960). In French.

Low and Mean Energy Nuclear Physics Colloquium, Grenoble, 1960 (see Abstr. 12029 of 1961). Explained theoretically by Debye's theory of crystals for a specified temperature, nucleus and crystal lattice. The effects of absorption, self-absorption and scattering are calculated, with both static and moving sources and absorbers, and experimental results are given. The application of the effect to the Zeeman effect, the electric quadrupole effect, scattering coherence, gravitational red shift, etc. is discussed, and its interest for general physics, solid state studies and nuclear physics considered.

17395 SCATTERING OF PHOTONS BY ATOMS AND NUCLEI IN CRYSTALS. C.Tzara.
J. Phys. Radium (France), Vol. 22, No. 5, 303-7 (May, 1961). In French.

Studied theoretically with or without the transfer of phonons. Depending on the width of the excited (nuclear or atomic) state, compared with the crystal vibration spectrum, the proportion o recoilless scattering varies between two limits: The Debye-Wa factor on one side, and the square of the Mössbauer—Lamb on t other. Interference between the atomic and nuclear processes examined. Finally the recoilless emission of a nuclear photon following a sequence of transitions is calculated without recour to a rearrangement phenomenon in the crystalline state.

17396 APPROXIMATE CALCULATION OF FREQUENCIES LOCALIZED VIBRATIONS. O.Litzman and J.Celý
Czech. J. Phys., Vol. 11, No. 5, 320-3 (1961).

An exact calculation of the frequencies of localized vibratio a crystal with defects meets with considerable difficulties and t fore calculations have been made for only the simplest cases. A approximate calculation is confined to computing the frequencie a system composed of several atoms in the neighbourhood of the defect. The interaction between this system and the other atom the lattice, which however are immobile in this approximation, taken into consideration. Since the analytical estimate of the ap mation is very rough, the approximate and exact calculations we compared for some concrete cases. It is clear from these calc tions that the use of the proposed approximation leads to good r sults.

17397 THE EXPERIMENTAL DETERMINATION OF THE SPECTRUM OF THERMAL VIBRATIONS IN CRYST WITH ARBITRARY SYMMETRY USING INCOHERENT ONE-PHONON SCATTERING OF COLD NEUTRONS. L.V.Tarasov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1431-5 (May, 1961). In Russian.

It is shown that in the general case of a monocrystal of arbitrary symmetry, the frequency function is a linear combina of three scattering cross-sections measured at three arbitrary orientations of the specimen, fixed relative to its main axes. It also shown that for a polycrystalline specimen which is macro-isotropic, the scattering cross-section is, within a temperature dependent factor, just the frequency function. [English translati Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1039-41 (Nov., K.G.

17398 WAVEFORMS OF THE LATTICE VIBRATIONS OF DIAMOND.
V.Chandrasekharan, E.S.Rajagopal and R.S.Krishnan.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 4, 377-91 (July 16,

A simplified procedure of studying the lattice wave propag along the special directions like [100], [111], [011] of diamond is presented. Besides furnishing the usual parameters of the wav the present method of using planar force constants gives intere results about the modes of vibrations, for example, the plane o polarization of the transverse waves along the cubic directions and the variations of the absolute phase difference between the lattices. Along the dodecahedral direction, the longitudinal wav gets coupled with one of the transverse waves, resulting in elli vibrations which can be discussed in a Poincaré representation Numerical calculations to illustrate the dispersion of the lattic waves are also given using the force constants up to the third neighbours.

17399 LATTICE FREQUENCIES AND SPECIFIC HEATS O GERMANIUM AND SILICON. B.Sharan and S.P.Sin
J. sci. Res. Banaras Hindu Univ. (India), Vol. 10(1), 60-6 (1959 publ. Dec., 1959).

An analysis of experimental data on specific heats and elas constants based on Raman's theory of lattice frequencies.

R.O.D

17400 VIBRATIONAL SPECTRUM AND SPECIFIC HEAT POTASSIUM. S.K.Joshi and M.P.Hemkar.
Physica (Netherlands), Vol. 27, No. 8, 793-96 (Aug., 1961).

The vibrational spectrum of potassium is computed using Bhatia's three-force-constant model for monovalent metals. T lattice specific heat is calculated and compared with the experi data.

17401 DOUBLE PHONON PROCESSES IN CADMIUM SULFIDE. M.Balkanski and J.M.Besson.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2292-7 (Oct., 19

"Semiconducting Compounds" Conference Paper, Schenecta 1961 (see Abstr. 14428 of 1961). The bands of infrared absorp in hexagonal cadmium sulphide were studied over a wide range

rature and are assigned to double-phonon processes. An is of these absorption peaks on the basis of four frequencies posed. The temperature-dependence of the location and ity of these bands give indications upon the anharmonic para- and Grüneisen constant of the crystal. Anharmonic forces own to be responsible for the coupling between normal vibra- modes.

402 INVESTIGATION OF ULTRASONIC ABSORPTION BY A METAL IN A MAGNETIC FIELD.
alkin, É.A.Kaner and A.P.Korolyuk.
:sper. teor. Fiz. (USSR), Vol. 39, No. 6, 1517-28 (Dec., 1960).
sian.
esults are presented of a theoretical and experimental study magnetoacoustic resonance and of the absorption coefficient ltrasonic waves in a magnetic field H. The investigation to tin and indium single crystals and short-wave sound) for $k \perp H$ (k is the wave vector, λ the wavelength of the , and l is the length of the electron path). It is shown that pes of oscillations occur in tin: resonance nonharmonic ations and sinusoidal oscillations. Those of the first type :cribed to the existence of an open Fermi surface in tin. The l of the open surface, computed on the basis of the oscillation ls, is in agreement with crystallographic data. The anisotropy oscillation periods along various crystallographic directions lied. The anisotropy and frequency dependence of saturation n a strong field is investigated. An analysis of the periods, :udes, oscillation phases, and absorption curve shapes in tin with the model of a Fermi surface in the form of a plane rk of "corrugated" cylinders directed along the [1$\bar{1}$0] and crystallographic axes. The reasons for some quantitative epancies between the theory and experiment are discussed. sh translation in: Soviet Physics—JETP (USA), Vol. 12, 1055-63 (June, 1961)].

403 SPIN—ACOUSTIC RESONANCE IN PARAMAGNETIC METALS. V.I.Gerasimenko.
ksper. teor. Fiz. (USSR), Vol. 40, No. 2, 585-9 (Feb., 1961).
ssian.
The resonance absorption of ultrasonic energy is found, brought by the interaction of acoustic vibrations of the lattice with the cteristic magnetic moments of the conduction electrons. sh translation in: Soviet Physics—JETP (USA), Vol. 13, No. 2, 2 (Aug., 1961)].

404 RELAXATION ABSORPTION OF SOUND IN A PARAMAGNETIC SUBSTANCE. B.I.Kochelaev.
ksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 423-8 (Aug., 1961).
ssian.
The absorption of sound in paramagnetic crystals due to spin— e interaction is considered theoretically. The estimations of agnitude of the absorption coefficient of sound show that the may be quite readily observed experimentally. [English ation in: Soviet Physics—JETP (USA)].

405 CONTRIBUTION TO THE STUDY OF THE PROPAGATION OF [LONGITUDINAL] ULTRASONIC WAVES IN ROGENEOUS MEDIA. M.L.Gaulard.
Phys. (France), Vol. 6, No. 3-4, 427-66 (March-April, 1961).
nch.
escribes investigations of the dependence of ultrasonic ption and of velocity (in the regions 50 kc/s and 1·1-6 Mc/s) mechanical properties of various iron ores, of mortars hardening, and of steels with various grain sizes. Absorp- proportional to frequency with anomalies as the wavelength aches the grain size. Calculations of scattering in an artifi- edium consisting of alternate layers of high- and low- ance agree with absorption measurements in steels and show fect of the intergranular material on the overall attenuation. V.J.Hammond

406 ULTRASONIC INVESTIGATIONS IN DEFORMED NaCl CRYSTALS. L.G.Merkulov and L.A.Yakovlev.
, Zh. (USSR), Vol. 6, No. 2, 244-51 (1960). In Russian.
The absorption and velocity of ultrasonic waves were measured. eformation, frequency, orientation, amplitude, and time dence of the absorption coefficient were investigated. The ts are evaluated, indicating the significant role of the ation mechanism of absorption. [English translation in: Physics—Acoustics (USA), Vol. 6, No. 2, 239-45 Dec., 1960)].

PHONON DRAG IN ZnO AND CdS. See Abstr. 17857

17407 DISLOCATION RELAXATION AT HIGH FREQUENCIES. P.G.Bordoni.
Nuovo Cimento Suppl. (Italy), Vol. 17, No. 1, 43-91 (1960).
A review is given of the dislocation relaxation for acoustic vibrations in f.c.c. metals. The first part of the paper discusses the experimental evidence of a thermally activated relaxation due to dislocations and the existing theories explaining the effect. Various models for the dislocation motion are used to compute characteristic relaxation times for six metals. The second part of the paper consists of detailed discussions of the parameters influencing the dislocation relaxation effect. These include activation energy, relaxation spectrum, frequency relaxation, subsidiary dissipation peaks, and relaxation peaks in alloys. The influence of impurity content, neutron irradiation, thermal and mechanical treatments on the shape of the relaxation peak is also demonstrated. From these results the author suggests a model for dislocation motion which is based on the formation of kink pairs. Their potential barrier and characteristic frequency depend only on the physical parameters of the single dislocations; the number of active dislocations is changed by high energy radiation, increasing impurity content, and by annealing. W.G.Mayer

17408 ELECTRON—PHONON INTERACTION IN NORMAL METALS. J.J.Quinn.
Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 58-66; Disc., 67-71.
An electron self-energy approach is used to study the effect of the electron—phonon interaction on the low-temperature electronic properties of normal metals. The self-energy of a single additional electron, due to virtual emission and reabsorption of phonons, is calculated by perturbation theory along lines already laid out by Fröhlich. The self-energy and its derivative with respect to momentum are evaluated at the Fermi surface. Although the former gives a negligible contribution to the single-particle energy, the latter is found to considerably enhance the density of states. A rough estimate indicates that umklapp as well as normal processes are of importance in the self-energy calculation. The enhanced density of states should be manifest in measurements of the low temperature electron specific heat and cyclotron resonance. In contrast to these, it is shown that the magnetic spin susceptibility is unaffected by the electron—phonon interaction, at least to this order of perturbation theory. This last result is shown to be independent of the exact form of the matrix element for phonon emission, and is valid whether or not umklapp processes are included.

ELECTRON—PHONON INTERACTION IN ALKALI METALS. See Abstr. 17438

17409 ELEMENTARY DERIVATION OF THE ELECTRON—ELECTRON INTERACTION VIA THE PHONON FIELD. R.N.Hill.
Amer. J. Phys., Vol. 29, No. 11, 739-40 (Nov., 1961).
The electron—electron interaction via the phonon field is calculated from classical physics. A transition to quantum mechanics via the correspondence principle then yields the matrix element which is the starting point of the Bardeen—Cooper—Schrieffer theory of superconductivity.

17410 SELF-TRAPPING OF AN ELECTRON BY THE ACOUSTICAL MODE OF LATTICE VIBRATION. I. Y.Toyozawa.
Progr. theor. Phys. (Japan), Vol. 26, No. 1, 29-44 (July, 1961).
The importance of the acoustical mode of lattice vibration for self-trapping of an electron is emphasized. It is shown that when the coupling constant between the electron and the acoustical mode vibration exceeds a certain critical value, the effective mass of the electron changes discontinuously to such an enormous value that it is practically allowed to take a localized self-trapping state as an eigenstate, in contrast to the case of the polaron, in which the effective mass changes continuously with coupling constant. This difference is attributed to the different force range of electron—lattice interaction in the two cases.

Thermal Properties

SOME THERMAL PROPERTIES OF In_2Te_3 AND Ga_2Te_3. See Abstr. 17744

17411 EXTENSION OF THE RANGE OF VALIDITY OF THIRRING'S EXPANSION FOR THE SPECIFIC HEAT OF CRYSTALS. R.A.Sack, A.A.Maradudin and G.H.Weiss.
Phys. Rev. (USA), Vol. 124, No. 3, 717-22 (Nov. 1, 1961).

Thirring (1913) obtained an expansion for the vibrational contribution to the specific heat of a crystalline solid in powers of $1/T^2$. The coefficients of this series are proportional to successive moments of the frequency spectrum. In its original form Thirring's expansion converges only for $T > T_a$, where $T_a = \hbar\omega_L/2\pi k$ and ω_L is the maximum normal mode frequency, and because of slow convergence, it is useless from a numerical point of view for $T < 4T_a/3$. The range of convergence of the expansion can be extended to absolute zero and its computational usefulness down to $T \cong 2T_a/3$ by means of an Euler transformation, which effectively converts it into an expansion in $1/(T^2 + T_b^2)$ with $T_b \cong T_a$. The improvement in convergence is so efficient that, usually, only the first 6 or 7 even moments are required to obtain four-figure accuracy at $T = T_a$. Alternatively, nonlinear transformations can be applied if the specific heat is to be calculated for a few values of temperature only. Some examples of the use of these methods are presented. Conversely, Euler's transformation provides a means for a more detailed description of the frequency distribution from specific heat measurements.

17412 HEAT CAPACITY, THERMAL EXPANSION AND ELECTRICAL RESISTIVITY OF AN 8 a/o ALUMINUM—PLUTONIUM (DELTA-PHASE STABILIZED) ALLOY BELOW 300°K. T.A.Sandenaw.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 329-36 (Nov., 1960).

The heat capacity and thermal expansion data for a delta-phase stabilized Al—Pu alloy are represented by curves and least-squares equations for the temperature region below 300°K. A curve for electrical resistivity of the alloy is given. The results of physical measurements indicate the major role of time-dependent cooperative phenomena. Values of the electronic contribution coefficient, Debye characteristic temperature, entropy, and enthalpy are reported, and comparisons made of the observed behaviour of high-purity plutonium and the stabilized alloy.

17413 THE SPECIFIC HEAT OF PURE COPPER AND OF SOME DILUTE COPPER + IRON ALLOYS SHOWING A MINIMUM IN THE ELECTRICAL RESISTANCE AT LOW TEMPERATURES. J.P.Franck, F.D.Manchester and D.L.Martin.
Proc. Roy. Soc. A (GB), Vol. 263, 494-507 (Oct. 10, 1961).

The specific heat of pure copper and of some dilute alloys of iron in copper, containing approximately 0.05, 0.1 and 0.2 at.% iron, were measured in the temperature range 0.4 to 30°K. The electrical resistance of the copper—iron alloys was measured from 0.4 to 80°K. The alloys show specific-heat anomalies which probably extend from the absolute zero of temperature to the region of the minimum in electrical resistance. The entropy contents of the anomalies lie close to the value R ln 2 per mole of iron suggesting that only two energy states of the iron ions are involved in the resistance minimum phenomena. The results are discussed in relation to existing theories.

17414 SPECIFIC HEAT OF A BODY-CENTERED CUBIC Cr—Fe ALLOY BETWEEN 30° AND 110°K.
Chuan-tseng Wei and Chin-huan Cheng.
Phys. Rev. (USA), Vol. 124, No. 3, 722-3 (Nov. 1, 1961).

The specific heat of a body-centred cubic alloy, $Cr_{80.6}Fe_{19.4}$, was determined between 30° and 110°K. The electronic specific heat coefficient γ and the Debye characteristic temperature were evaluated between 40° and 60°K to be $(46 \pm 5) \times 10^{-4}$ cal $mole^{-1}$ deg^{-2} and 472 ± 14°K, respectively. The origin of a sharp peak occurring at 37 ± 2°K is discussed.

17415 SPECIFIC HEATS OF $DyCl_3.6H_2O$ AND $NdCl_3.6H_2O$ IN THE TEMPERATURE REGION BETWEEN 1.2°K AND 220°K. W.Pfeffer.
Z. Phys. (Germany), Vol. 164, No. 3, 295-302 (1961). In German.

Calorimetric measurements of the specific heats of $DyCl_3.6H_2O$ (A) and $NdCl_3.6H_2O$ (B) are reported. The differences A-C and B-C, where C is the lattice specific heat of $GdCl_3.6H_2O$ are compared with the spectroscopically evaluated electronic specific heats of A and B. The lattice specific heats of the three salts are inversely proportional to the respective molecular weights.

R.F.S.Hea

17416 THERMAL PROPERTIES OF GRAPHITE, MOLYBDENUM AND TANTALUM TO THEIR DESTRUCTION TEMPERATURES. N.S.Rasor and J.D.McClelland.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 17-26 (Aug., 196

Thermal expansion, specific heat and thermal conductivity determined from 1000°C to near the destruction temperature of molybdenum (m.p. 2620°C), tantalum (m.p. 3000°C) and four types of graphite (which sublimes at 3650°C). The thermal expansion for the materials investigated show no grossly unusual features except those due to impurity evolution. The specific heat of the metals, particularly that of molybdenum, appreciably exceeds the Dulong—Petit value. However, their thermal conductivities follow closely the Lorenz (Wiedemann—Franz) relation for free electrons. At intermediate temperatures (1000-2800°C) the thermal conductivity and specific heat of graphite show no unusual features. At temperatures, however, large and rapid increases in specific heat and thermal resistivity appear, which are consistent with the presence of thermally produced lattice defects, presumably vacancy lattice sites. A defect concentration of about 0.5 at.% at the sublimation temperature, and a formation energy in the vicinity of 7.7 eV, are indicated.

17417 THE SPECIFIC HEAT OF $MnCl_2.4H_2O$ BETWEEN 0.9°K AND 4.2°K AT THREE DIFFERENT MAGNETIC FIELDS: 2.84, 7.61 AND 10.48 kOe.
W.H.M.Voorhoeve and Z.Dokoupil.
Physica (Netherlands), Vol. 27, No. 8, 777-82 (Aug., 1961).

The specific heat of $MnCl_2.4H_2O$ was measured in a powdered salt at different field strengths in the helium temperature range. From this some information is obtained about the entropy change connected with the transition from the antiferromagnetic state to the paramagnetic state.

17418 HEAT CAPACITY AND RESISTIVITY ANOMALIES IN PALLADIUM HYDRIDE. P.Mitacek, Jr and J.G.A
Nature (GB), Vol. 191, 271 (July 15, 1961).

A heat-capacity maximum at 55°K is found in solutions of hydrogen in palladium: this is probably related to the resistivity maximum [International Institute of Refrigeration, Denmark (

M.A.

SPECIFIC HEAT OF POTASSIUM. See Abstr. 17400

17419 LOW-TEMPERATURE SPECIFIC HEAT OF DILUTE Cu—Mn ALLOYS. J.E.Zimmerman and F.E.Hoar
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 52-6 (Dec., 196

Specific heats of several specimens of copper alloyed with from 0·14 to 10 wt.% manganese were measured at liquid helium temperatures, and for some of the specimens, measurements were extended to 15°K. All exhibit an anomalously large specific heat compared to pure copper, of which the excess is associated with the magnetic transition known to occur in these alloys at low temperatures. The excess entropy associated with the anomaly indicates a spin on the manganese atoms of about 2; but for a number of reasons this spin cannot be established accurately. The shape of the specific heat anomaly is different from any of the well-known theoretical forms, e.g., the Schottky or the λ-point types. At the lowest temperatures the excess specific heat is linear in T and essentially independent of Mn concentration for the entire range of composition studied.

17420 LOW-TEMPERATURE SPECIFIC HEAT OF GERM
C.A.Bryant and P.H.Keesom.
Phys. Rev. (USA), Vol. 124, No. 3, 698-700 (Nov. 1, 1961).

Electronic and lattice contributions to the specific heat are reported for several n-type degenerate Ge ingots. The electron effective mass, calculated on the assumption of a parabolic conduction band, is not strongly dependent on donor concentration in Ge. The Debye temperature decreases as donor or acceptor impurities are added, from 371°K for pure Ge to 362°K for the heavily doped ingot. However, this marked decrease did not occur in silicon-doped Ge. It is suggested that the effect is due to screening of long-range lattice forces by free electrons or ho

21 THE ELECTRONIC SPECIFIC HEAT OF LITHIUM ISOTOPES. D.L.Martin.
Roy. Soc. A (GB), Vol. 263, 378-86 (Sept. 19, 1961).
e specific heats of "natural" lithium (predominantly Li^7) and
ım containing 99.3% Li^6 were determined from 0.4 to 1.5°K.
.s no significant difference in the electronic specific heats,
fficient of this term being about 390 μcal $(°K)^{-2}$ g-atom^{-1}
$(°K)^{-2}$ g-atom^{-1}). The significance of this result is dis-

22 HYPERFINE STRUCTURE IN TERBIUM METAL. B.Bleaney and R.W.Hill.
Phys. Soc. (GB), Vol. 78, Pt 2, 313-15 (Aug., 1961).
e hyperfine contribution to the specific heat of metallic Tb
ınd (Abstr. 6929 of 1958) to be smaller than that expected
lectron paramagnetic resonance experiments (Abstr. 4441 of
n terbium ethyl sulphate. The discrepancy may be resolved
ng into account the electric quadrupole interaction with the
leus Tb^{159}. J.Thewlis

23 NUCLEAR CONTRIBUTION TO THE HEAT CAPACITY OF TERBIUM METAL. E.C.Heltemes and C.A.Swenson.
ı. Phys. (USA), Vol. 35, No. 4, 1264-5 (Oct., 1961).
e heat capacity of terbium metal was measured between 0.25°
°K. The high temperature data can be expressed as
$R \times 10^{-3}/T^2$ cal/mole-deg which is in excellent agreement
e paramagnetic resonance experiments of Baker and
y on terbium ethyl sulphate. The data are compared with a
y formula for the heat capacity, assuming equal spacing
ı the nuclear hyperfine levels with an over-all spacing of
5°K, corresponding to the high temperature expression above.
reement is within experimental error except at the very
temperatures obtained. The effective field at the nucleus of
ɔium atom can be calculated and is found to be $H_{eff} = 4 \times 10^6$

24 NUCLEAR SPECIFIC HEAT OF HOLMIUM. J.E.Gordon, C.W.Dempesy and T.Soller.
Rev. (USA), Vol. 124, No. 3, 724-5 (Nov. 1, 1961).
ıe specific heat of holmium was measured between 0.95°
°K. The magnetic hyperfine interaction in holmium is so
hat over this entire temperature range the nuclear hyperfine
epresents the predominant contribution to the specific heat.
1.5°K the specific heat appears to be that of an ideal
agnetic gas of spin ½. At 1°K the specific heat has the ex-
large value of 0.37R.

25 REINTERPRETATION OF DISCORDANT X-RAY RESULTS FOR THE DEBYE TEMPERATURE OF R. F.H.Herbstein.
Mag. (GB), Vol. 6, 863-9 (July, 1961).
ıe values given in the literature for the Debye temperature of
as a function of temperature have been derived from measure-
of elastic constants and from the temperature variation of
intensities. The results from the different experimental
ues are not in good agreement. However, it is shown that
pretation of the X-ray measurements, by a method due to
n (Abstr. 20747 of 1960) gives new values which agree
ctorily with the elastic-constant values.

26 THERMAL EXPANSION OF ICE. S.Laplaca and B.Post.
ryst. (Internat.), Vol. 13, Pt 6, 503-5 (June 10, 1960).
sults of X-ray diffraction measurements, over the tempera-
nge −180° to 0°C, on hexagonal specimens showing high
s of preferred orientation, are shown graphically. The values
attice constants c, a, c/a and the coefficients of thermal
ion perpendicular and parallel to c at 10°C intervals are
ed. The X-ray values show more anisotropy of expansion
latometric measurements, with major differences between
and −130°C, where the expansion perpendicular to c is
ous. Between these temperatures the value of a is practically
ged, though the value of c varies normally. The values of
l within the range 1.6288 ± 0.0003. S.Weintroub

27 THERMAL DILATION IN CRYSTALLINE MEDIA. I. DILATION FACTORS. J.Laval.
s. Radium (France), Vol. 22, No. 7, 451-8 (July, 1961).
nch.
y oscillation, atoms exert repulsive forces upon one another, which result in thermal strains. When the temperature rises, the thermal strains increase and dilate the crystalline medium. The subject of this first study is thermal strains in metallic cubic crystals. It is supposed that each fundamental oscillation of the thermal agitation keeps the same average energy as that of an harmonic oscillator; and thermal strains are estimated with reference to temperature in a crystalline medium free from any constraint.

17428 THERMAL EXPANSION AT LOW TEMPERATURES. II. ELECTRONIC COMPONENT IN METALS. G.K.White.
Phil. Mag. (GB), Vol. 6, 815-18 (June, 1961).
For earlier work see Abstr. 17901 of 1960. Data for α, the linear thermal expansion coefficient at temperatures below 10°K, for Cu, Al, Pd, Fe, Cr and Be, obtained from the earlier measurements made by the capacitance method [Cryogenics, Vol. 1, 151 (1961)], can be expressed as $\alpha = aT + bT^3$ or $\alpha = \alpha_e + \alpha_g$, where α_e and α_g are the electron-gas and crystal-lattice contributions. Values for α_e, α_g and the corresponding values of the Grüneisen constants γ_e and γ_g are tabulated and briefly discussed. Large negative values of α_e and γ_e occur for Cr. S.Weintroub

17429 THE CALCULATION OF THE GRÜNEISEN CONSTANT FOR METALLIC SILVER. I.Biro.
Acta phys. Hungar., Vol. 13, No. 1, 99-102 (1961). In German.
The constant (γ) is determined at absolute zero as a function of pressure and atomic volume using the statistical model of a metal due to Gombas (Abstr. 8707 of 1951). No empirical or semi-empirical parameters are employed. For zero pressure it is found that $\gamma = 17/6$ in satisfactory agreement with the value found by Slater using a semi-empirical method [Introduction to Chemical Physics, New York; Toronto; London: McGraw-Hill Book Company (1939) p. 451]. J.W.Leech

17430 A METHOD SUITABLE FOR THE MEASUREMENT OF THE THERMAL DIFFUSIVITY OF IRRADIATED MATERIALS. D.Smart.
J. nuclear Materials (Internat.), Vol. 2, No. 4, 341-9 (Dec., 1960).
A description is given of a transient method which is suitable for measuring thermal diffusivity of irradiated materials. The time taken for the measurement is short and some of the difficulties normally encountered in handling and machining radioactive material, prior to such a measurement, are avoided. The theory is developed, a prototype test equipment described and results quoted for brass, steel, natural uranium (unirradiated), copper and aluminium. For brass, steel and natural uranium specimens the accuracy is better than ±5% of the accepted values reported in the literature. The accuracy for aluminium and copper could be improved by using longer specimens in a modified apparatus. The measurement is of the macroscopic thermal conductivity, i.e. averaged over an area much greater than that of a single crystallite.

THEORY OF THERMAL CONDUCTIVITY OF ALKALI METALS.
See Abstr. 17439

17431 THERMAL CONDUCTIVITY OF $BaTiO_3$-BASED MANGANESE NIOBATE SOLID SOLUTIONS. F.F.Kodzhespirov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 781-5 (March, 1961). In Russian.
Measurements made between 30 and 150°C on $(100-x)BaTiO_3 + xMn_3Nb_2O_7$ $(0 \leq x \leq 7)$. The conductivity κ decreases with increasing temperature ($\kappa \propto T^{-0.82}$) and with increasing x, $[(\kappa/\kappa - 1) \propto x]$, except near the Curie points where there is an anomalous increase in conductivity. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 567-70 (Sept., 1961)]. R.Berman

17432 THE TRANSFER OF HEAT BY THE BIPOLAR DIFFUSION OF CURRENT CARRIERS IN LEAD TELLURIDE AND SELENIDE. E.D.Devyatkova, A.V.Petrov and I.S.Smirnov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1338-41 (May, 1961). In Russian.
For abstract, see Abstr. 14189 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 970-3 (Nov., 1961)].

17433 THE THERMAL CONDUCTIVITY OF HIGH PURITY THALLIUM AND TIN. N.V.Zavaritskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1571-7 (Dec., 1960). In Russian.

The thermal conductivity of several thallium and tin single crystals of varying purity was studied in the normal (K_n) and superconducting (K_S) states. A deviation from additivity was found in the electron scattering processes in the normal state. The variation in K_S/K_n when the scattering of electrons changes from being due to lattice defects to being due to thermal vibrations is investigated. The results obtained are compared with the theoretical predictions. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1093-7 (June, 1961)].

THERMAL CONDUCTION IN NORMAL AND SUPERCONDUCTING TIN AND INDIUM. See Abstr. 16201

ELECTRON STATES

17434 SOME PROPERTIES OF HIGHLY COMPRESSED MATTER. I. A.A.Abrikosov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6, 1797-1805 (Dec., 1960). In Russian.

The ground-state energy of matter at very high densities is calculated. In contrast to the assumptions made by Gell-Mann and Brueckner (1957), and Savada (1957), it is shown that the ions form a crystal lattice. The moduli of elasticity and the oscillation spectrum of the lattice are determined. The destruction of the lattice at extremely high densities is discussed. The electron–ion correlation energy is calculated. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 6, 1254-9 (June, 1961)].

17435 SOME PROPERTIES OF HIGHLY COMPRESSED MATTER. II. A.A.Abrikosov.
Zh. eksper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 569-82 (Aug., 1961).

For Pt I see preceding abstract. The interaction between electrons and ions in highly compressed matter is investigated. The possibility of superconductivity is discussed. The spectrum and damping of the electron excitations of highly compressed hydrogen are derived.

17436 PARAMAGNETIC SUSCEPTIBILITY OF CONDUCTION ELECTRONS CALCULATED BY THE AID OF ANALYTICAL FORMULAS FOR THE THEORY OF THE FORMATION OF ELECTRON GROUPS IN THE PERIODIC SYSTEM OF ELEMENTS. T.Tietz.
Acta phys. Hungar., Vol. 12, No. 4, 291-5 (1960).

The paramagnetic susceptibility of conduction electrons is calculated by means of the modified formulae of Pauli. The results are compared with the experimental values.

17437 THE VELOCITY AND EFFECTIVE CHARGE OF THE PARTICLES NEAR THE FERMI SURFACE. L.M.Falicov.
Fermi Surface Conference Paper, Ccoperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 39-49; Disc., 67-71.

The transport properties of a metal, taking account of the electron–electron interaction, can be explained in terms of elementary excitations of the electron gas. These excitations or quasi-particles, electron-like or hole-like, can be defined in k-space only near the Fermi surface and they behave nearly independently of each other. Considering the case of only one quasi-particle, it is shown that its velocity is still given by the relation

$$\vec{v}_k = \frac{1}{\hbar} \operatorname{grad}_k \epsilon(k)$$

where $\epsilon(k)$ is the single quasi-particle energy; however the charge carried by the excitation is no longer e, the electronic "bare" charge, but an effective charge e_k^*, smaller than e. For the free-electron case it is proved that

$$e_k^* = \frac{e\hbar}{m} \frac{|k|}{|\vec{v}_k|}$$

and therefore the contribution to the current due to one quasi-particle is equal to the current carried by a free non-interacting electron which has the same k-vector. Using the Bohm and Pines values for the single particle energies, it is found that

$$e_k^*/e \cong 0.9.$$

In all the formulae concerning transport properties based on th independent particle model, the electronic charge e must be replaced by e_k^*, which gives rise to an appreciable correction. can be important in evaluating the geometrical properties of th Fermi surface obtained from experimental data.

17438 LOW-TEMPERATURE TRANSPORT PROPERTIES THE ALKALI METALS. I. THE ELECTRON–PHONON INTERACTION. J.G.Collins.
Proc. Roy. Soc. A (GB), Vol. 263, 531-44 (Oct. 10, 1961).

The form of the electron–phonon matrix element is calcul for metals with non-spherical Fermi surfaces by using electro wave-functions, which are linear combinations of two plane wa as in the model of nearly free electrons. Numerical calculatio are made with the use of the "twelve cone" approximation to th Brillouin zone. It is shown that, if the Fermi surface bulges towards the zone faces, there is a significant increase in the probability of umklapp scattering of electrons, the increase de ing on the amount of distortion of the Fermi surface, and on th symmetry properties of the electron wave functions. The incr in umklapp scattering has important consequences for calculat of the resistivities of metals, and particularly for calculations "phonon drag" contribution to the thermoelectric power. (See following abstract).

17439 LOW-TEMPERATURE TRANSPORT PROPERTIES THE ALKALI METALS. II. THE TRANSPORT COEFFICIENTS. J.G.Collins and J.M.Ziman.
Proc. Roy. Soc. A (GB), Vol. 264, 60-87 (Oct. 24, 1961).

The theory of Pt I (see preceding Abstr.) is applied to the direct calculation of the "ideal" electrical and thermal resisti and "phonon drag" thermo-electric power, of the alkali metals three coefficients depend, in magnitude and as functions of tem ture, on the shape of the Fermi surface and on the lattice spec If it is assumed that the latter is identical in form for all meta the group, the observed transport coefficients are consistent w Fermi surface which is quite distorted in lithium, becomes ne spherical in sodium and potassium, and is again distorted in rubidium and caesium. The argument is not sufficiently accur discriminate between s-like and p-like symmetry in each case to decide whether the Fermi surface actually touches the zone boundary; the phonon drag effect is also very sensitive to the p of the specimen.

17440 ELECTRONIC STRUCTURE FROM THE ONE-O.P [ORTHOGONALIZED PLANE WAVE], OR NEARL FREE-ELECTRON, POINT OF VIEW. W.A.Harrison.
Fermi Surface Conference Paper, Cooperstown, New York, Au 1960 (see Abstr. 11180 of 1961) p. 28-38; Disc., 67-71.

The nature of this point of view is described in physical te and some discussion of the extent of its validity is made. Seve electronic properties are then surveyed and, utilizing this pict of the band structure, a study is made of the extent to which as of the electronic behaviour other than the geometry of the Fer surface are important in determining these properties. It is n that though the usual one-electron point of view may well yield description of the geometry of the Fermi surface, more compl effects must certainly be included in an understanding of prope related to an effective mass. The contribution to the total ene of the electron systems due to "Brillouin-zone overlaps" is es ted and found to be negligible, at least in aluminum, with respe properties such as the elastic constants. Some discussion is m of the properties of alloys and in particular of the "rigid-band model", and the determination of Fermi surfaces in ordered a is illustrated. Finally, the behaviour of simple electronic syst in crossed electric and magnetic fields is discussed.

17441 THE ENERGY BAND SYMMETRY IN WURTZITE-CRYSTALS. II. BAND SYMMETRY WITH ALLOW FOR SPIN INTERACTIONS. É.I.Rashba and V.I.Sheka.
Fiz. tverdogo Tela (USSR), Sbornik [Supplement] II, 162-76 (19 In Russian.

For Pt I, see Abstr. 1543 of 1960. Irreducible representa of the space group C_{6v}^4 (wurtzite-type lattice) are listed. A va of the perturbation theory is given which can be used to study dispersion law near symmetry elements with allowance for sp interactions; for some points, new dispersion laws are obtaine

-theoretical analysis of the energy bands in wurtzite-type
s allows for spin interactions. The possibility of the existence
rgy surfaces E(k) with extrema along complete curves,
d of extrema at isolated points of the k-space, is established.
A.Tybulewicz

442 HYDROGEN-LIKE IMPURITY STATES IN AXIALLY SYMMETRIC CRYSTALS. R.W.Keyes.
. Res. Developm. (USA), Vol. 5, No. 1, 65-6 (Jan., 1961).
xtends previous calculations to take into account the anisotropy
dielectric constant tensor and presents numerical results for
se in which the transverse mass is greater than the longitudinal
(CdAs$_2$ and strained p-type silicon). L.Pincherle

443 ELECTRONIC BAND STRUCTURE IN ALLOYS AND LIQUID METALS. V.Heine.
Surface Conference Paper, Cooperstown, New York,
1960 (see Abstr. 11180 of 1961) p. 279-89; Disc., 309-16.
he first section discusses how the concept of electronic band
ure can be applied to disordered alloys and liquid metals.
econd section analyses some Knight-shift data on liquid binary
es of alkali metals. It is concluded that each atom in the
e sees a local spin susceptibility approximately equal to that
corresponding pure metal. The third section reviews present
about the band structure of the alpha-phase alloys of the noble
, with particular reference to the size of the band gap, the
onic specific heat, and the Hume—Rothery rule.

444 BAND STRUCTURE OF SOLID ARGON.
R.S.Knox and F.Bassani.
Rev. (USA), Vol. 124, No. 3, 652-7 (Nov. 1, 1961).
he orthogonalized plane-wave method, in a perturbation
ximation introduced by Bassani and Celli (Abstr. 7501 of 1959,
Phys. Chem.Solids, in press) is used to compute the lowest
conduction states in (f.c.c.) solid argon at the symmetry
Γ, X, L, and K. The 3s and 3p valence bands are treated by
binding theory. The potential used in the computation consists
um of effective atomic potentials in which a free-electron-like
ssion is used for the exchange contribution. The lowest
ction state appears to be s-like (Γ_1), lying 12.4 eV above the
t valence state (Γ_{15}). The results of the computation are
ared with present theoretical and experimental knowledge of
ectronic structure of the solid rare gases.

445 BAND STRUCTURE OF WURTZITE-TYPE CRYSTALS; INTRINSIC OPTICAL TRANSITIONS IN CdS.
anski and J.des Cloizeaux.
s. Radium (France), Vol. 21, No. 12, 825-34 (Dec., 1960).
nch.
he band structure near the centre of the Brillouin zone for
te-type crystals is deduced from group theory considerations.
taken as an example and the theoretical conclusions are
red to some experimental results. The introduction of spin
coupling leads to three complex valence bands originating from
lphur 3p levels. The maximum of the uppermost valence band
he centre of the Brillouin zone and the two lower valence
have six maxima near $\vec{k} = 0$. The conduction band originating
s cadmium levels has six minima near $\vec{k} = 0$. The optical
tions near the absorption edge include the band-to-band trans-
as well as exciton creation.

446 3d BAND STRUCTURE OF Cr.
M.Asdente and J.Friedel.
Rev. (USA), Vol. 124, No. 2, 384-90 (Oct. 15, 1961).
he electronic structure of the 3d band in Cr is calculated in
ght-binding approximation; the effect of the nearest-neighbour
ction and of the second-nearest-neighbour interaction on the
y surfaces in the Brillouin zone and on the density-of-states
g(E) is investigated. By means of group theory, an analysis
electron levels and of the eigenfunctions is performed in some
ular points of the Brillouin zones; bonding and antibonding
cters are found, together with different space distributions,
e eigenfunctions at the bottom and at the top of the band. A
arison with other theoretical results suggests that the details
chosen potential do not influence the general trend of the
urve very much; also satisfactory is a comparison with
imental results (particularly concerning electronic specific heat
agnetic susceptibility χ, and thermoelectric power).

17447 PRESSURE DEPENDENCE OF THE DIRECT ENERGY GAP IN GERMANIUM. M.Cardona and W.Paul.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 138-42 (Dec., 1960).
The pressure dependence of the energy gap corresponding to allowed optical transitions in germanium was measured at room temperature and pressures up to 7000kg/cm^2. This direct energy gap is found to increase at a rate of $1{\cdot}3 \pm 0{\cdot}1 \times 10^{-5}$ eV cm^2/kg, in agreement with previous approximate determinations and with the pressure coefficient of the same energy gap in group III-V compounds.

INTERBAND SCATTERING IN N-TYPE GERMANIUM.
See Abstr. 14448

17448 STUDY OF THE ELECTRONIC BAND STRUCTURE OF TELLURIUM BY MEANS OF TRANSPORT PHENOMENA.
C.Rigaux.
C.R. Acad. Sci. (France), Vol. 253, No. 1, 81-2 (July 3, 1961).
In French.
Reports measurements, parallel and perpendicular to the crystal axis of (1) Hall effect and thermoelectric power in the extrinsic region for bismuth doped samples; (2) magnetoresistance at 77° and 200°K; (3) piezoresistance; (4) Hall effect and thermoelectric power in the intrinsic region: a second sign reversal of these quantities is observed in this region. The results may be interpreted by assuming that the valence band edge consists of 12 ellipsoids and that there are two conduction bands with an energy separation of about 0.36 eV. L.Pincherle

ELECTRON ENERGY BAND STRUCTURE OF TELLURIUM.
See Abstr.14374

17449 THE GROUP THEORETICAL ANALYSIS OF α-URANIUM. M.Suffczynski.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 174-6 (Nov., 1960).
The free-electron approximation for α-uranium is investigated. The diffifulties of approaching the band structure of uranium are discussed. The representations of the double groups of α-uranium are given.

17450 ON THE METASTABLE γ-PHASE URANIUM—MOLYBDENUM ALLOYS. F.J.Blatt.
J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 177-87 (Jan., 1961).
The experimental data of Chandrasekhar and Hulm (resistivity) (Abstr. 3432 of 1959), of Berlincourt (Hall effect) (Abstr. 4320 of 1960) and of Goodman et al. (specific heat) [C.R. Acad. Sci. (France), Vol. 250, No. 3, 542-4 (Jan. 18, 1960)] are examined within the framework of the band model suggested by Friedel [J. Phys. Chem. Solids (GB), Vol. 1, 175 (1956)]. It is shown that all available data are consistent with a reasonable density of states curve, and the qualitative features of that curve are in agreement with those deduced by Friedel from the properties of pure uranium. Attention is directed to the thermoelectric power of these alloys as a means of further defining the band structure. Moreover, the thermoelectric power of certain uranium alloys may be large enough to be of practical interest.

17451 BAND STRUCTURE AND TRANSPORT OF HOLES AND ELECTRONS IN ANTHRACENE. O.H.LeBlanc, Jr.
J. chem. Phys. (USA), Vol. 35, No. 4, 1275-80 (Oct., 1961).
Previous mobility measurements indicate that the band approximation can be used to describe the behaviour of injected holes and electrons in anthracene, and the present theoretical investigation appears to confirm this. The structures of the bands appropriate to a hole or electron are calculated with the tight binding approximation. Hückel linear combinations of Slater-type atomic orbitals are used for the molecular basis functions. Both bands are highly anisotropic and each is found to be approximately 0.56 kT wide at room temperature. Mobility tensors are derived using a simplified treatment of scattering which assumes isotropic scattering parameters. The calculated mobilities exhibit roughly the anisotropy that has been observed experimentally. Magnitudes of the scattering parameters are estimated from the observed mobilities, and these are found to be reasonable (e.g., free path > lattice distances).

17452 THEORY OF THE FERMI SURFACE.
J.M.Luttinger.
Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 2-8; Disc., 67-71.
A discussion of the present state of the theory of the Fermi

surface for a system of interacting fermions is given. A listing of the specific results obtained by perturbation theory to arbitrary order is made, and a very brief indication of the essential theoretical tools (the theory of propagators) is presented.

17453 BAND CALCULATIONS OF THE SHAPE OF THE FERMI SURFACE IN THE ALKALI METALS.

F.S.Ham.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 9-27; Disc. 67-71.

A series of calculations of the energy bands of the alkali metals was carried out with the use of the Green's function method and the quantum defect method. Results relating to the shape of the Fermi surface are reported. The gap (N_S - N_p) at the (110) zone face is found to be + 0.225, + 0.019, -0.037, -0.064, -0.096 (in Rydbergs) for Li, Na, K, Rb, and Cs respectively. Accordingly, the Fermi surface is most distorted from a sphere in Li and Cs and very little distorted for Na and K, in agreement with Cohen and Heine's prediction (Abstr. 7497 of 1959) and their interpretation of available experimental data. These data are reviewed in the light of Bailyn's conclusions (1960) concerning the importance of umklapp processes in transport calculations and the likelihood that other effects influence the data as strongly as do distortions of the Fermi surface. It is concluded that it is not now possible to deduce the Fermi surface shape of the alkalies with any certainty from available experimental results. The Green's function method is compared with other cellular methods of calculation and found to be much more useful in giving rapid convergence and in avoiding a difficulty from which other cellular methods have suffered concerning the representation of the wave function in the cell corners. A simplified theory of band shapes due to Cohen and Heine is found to describe the position of N_S quite well, provided that the wave function does not have a large d component. Their theory does not describe N_p accurately, nor is the variation of band gap with lattice constant given correctly. The present results on the alkalies can be fitted by an interpolation formula derived by mixing nearly degenerate plane waves through a weak pseudopotential only if the latter is made l-dependent. While this dependence may be expected on general grounds, it introduces too many parameters to permit a simple description of the bands.

17454 THE EFFECT OF INTERACTIONS ON DETERMINATION OF FERMI SURFACES. E.A.Stern.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961). p. 50-7; Disc., 67-71.

The effect of both electron—electron and electron—phonon interactions on a degenerate electron gas in a uniform positive background is considered. It is shown that when electron—electron interactions alone are considered the free electron mass is still measured by cyclotron resonance, the Faraday effect, and optical constants. However, the period of the de Haas—van Alphen oscillations is changed from what one calculates neglecting interactions and is changed in the same way that the specific heat is. When electron—phonon interactions are added everything changes. In particular, it is shown that the cyclotron mass is no longer the free value, and the de Haas—van Alphen period and the specific heat are changed in different ways. Comparison with measurements on aluminium which approximates the model used shows that both electron—phonon and electron—electron effects are important and of the same magnitude.

17455 THE DE HAAS—VAN ALPHEN EFFECT. D.Shoenberg.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 74-82; Disc., 97-8.

The use of the de Haas—van Alphen effect as a tool for determination of the Fermi surface is reviewed with special reference to recent work on copper, silver and gold and to a number of polyvalent metals.

17456 LOW FIELD DE HAAS—VAN ALPHEN STUDIES OF THE FERMI SURFACE OF MAGNESIUM.

W.L.Gordon, A.S.Joseph and T.G.Eck.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 84-87; Disc., 97-8.

A null-deflection torsion method permitting automatic recording of torque as a function of 1/H was employed to study the de Haas—van Alphen oscillations in the magnetic susceptibility of single crystals of magnesium in fields up to 18 kgauss and at temperatures of 4.2° K and below. Analysis of the angular dependence of the de Haas—van Alphen periods on field orientation relative to crystalline axes has yielded external cross-section the Fermi surface which agree closely with portions of the free electron construction proposed by W.A.Harrison. Although neither the 0002 nor 10$\bar{1}$1 face overlaps were observed, this merely indicates a lower limit to their minimum cross-section of approximately 0.12 A^{-2} imposed by the sensitivity of the apparatus.

17457 MAGNETOTHERMAL OSCILLATIONS AND THE FERMI SURFACE.

J.E.Kunzler and F.S.L.Hsu.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 88-96; Disc. 97-8.

Magnetothermal oscillations show up experimentally as a reversible and cyclic variation of the temperature of a thermal isolated single crystal, such as bismuth, as the magnitude or the orientation of an applied magnetic field is changed in a uniform manner. The oscillatory temperature changes are periodic in and their variation with orientation is dependent on the detailed shape of the pertinent part of the Fermi surface in much the same manner as magnetic susceptibility oscillations. Susceptibility oscillations depend on the variation in the free energy while the magnetothermal oscillations involve only entropy changes and thus a direct measure of the variations in the density of electron states at the Fermi surface. Of the oscillatory effects used for study of Fermi surface shapes at moderate magnetic fields, magnetothermal oscillations appear to have yielded the best resolution. When in addition one considers the facility with which these observations can be made, studies of the Fermi surface by this method are very attractive. Brief descriptions of the method have been given recently. The higher resolution obtained with magnetothermal oscillations made it possible to observe the splitting of the Landau levels in bismuth. To the authors' knowledge the resolution of such splitting by other de Haas—van Alphen-type observations has not been reported.

17458 THEORY OF ULTRASONIC ATTENUATION IN METALS. A.B.Pippard.

Fermi Surface Conference Paper, Cooperstown, New York, Aug. 1960 (see Abstr. 11180 of 1961) p. 224-32; Disc. 258-63.

The forces acting on an electron when an acoustic wave passes through a real metal are analysed, and found to have their origin (apart from electromagnetic forces) in two separable effects—a deformation effect due to variations of the Fermi surface with strain, and a relative velocity effect arising when an electron travels between regions moving at different speeds. These effects may be simulated by fictitious forces acting on the electrons in an undeformed lattice, so that the response of the metal to the wave becomes a straightforward problem in conduction theory. Results are quoted and discussed briefly for a metal not subjected to a magnetic field, and for a metal in a transverse field when the free path is long enough to allow many revolutions of the cyclotron orbits. The factors determining the oscillatory magnetoacoustic effect are examined critically, and finally the influence of open orbits on the limiting attenuation in high magnetic fields is ana

17459 MAGNETOACOUSTIC EFFECTS IN LEAD AND TI A.R.Mackintosh.

Fermi Surface Conference Paper, Cooperstown, New York, Aug. 1960 (see Abstr. 11180 of 1961) p. 233-6; Disc., 258-63.

The results of a detailed study of transverse magnetoacoustic effects in lead are presented, and a form of Fermi surface suggested on the basis of this and previous experimental work. Measurements on ultrasonic attenuation in tin in longitudinal magnetic fields are described, and some features of the Fermi surface deduced from them.

17460 CHANGES OF LATTICE SPACINGS IN ALLOYS AND THE SHAPE OF THE FERMI SURFACE.

T.B.Massalski and H.W.King.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 290-5; Disc., 309-16.

Studies of systematic lattice spacing changes with composition in face-centred cubic and hexagonal close-packed alloys based on noble metals provide information which can be interpreted in terms of interactions of the Fermi surface with the Brillouin zone. Recent data on a large number of h.c.p. alloys shows a striking dependence of such interactions on the electron concentration. The influence of the solute elements on lattice spacings in silver-base alloys may be interpreted qualitatively by considering that the

aps of silver are modified by the additions of the solute nts. Such considerations enable tentative conclusions to be regarding the nature of the band structure in pure silver.

461 "ORDINARY" TRANSPORT PROPERTIES AND THE SHAPE OF THE FERMI SURFACE. J.M.Ziman.
Surface Conference Paper, Cooperstown, New York, 1960 (see Abstr. 11180 of 1961) p. 296-305; Disc., 309-16.
formation about the shape of the Fermi surface can be ed from the ordinary transport properties. The electrical vity suggests that metals in the second row of the periodic re nearest to the free electron model. The "phonon drag" bution to the thermoelectric power in the monovalent can be explained by distortion of the Fermi surface. To tand the "diffusion" thermoelectric power and Hall coefficients noble metals, one must assume that the relaxation time of the ons is much smaller at the zone boundaries than on the "belly" Fermi surface.

462 THEORETICAL SUMMARY [FERMI SURFACE CONFERENCE]. M.H.Cohen.
Surface Conference Paper, Cooperstown, New York, 1960 (see Abstr. 11180 of 1961) p. 318-29; Disc., 341-3.

463 EXPERIMENTAL SUMMARY [FERMI SURFACE CONFERENCE]. A.B.Pippard.
Surface Conference Paper, Cooperstown, New York, 1960 (see Abstr. 11180 of 1961) p. 330-40; Disc., 341-3.

464 FERMI SURFACE OF LEAD.
N.E.Alekseevskii and Yu.P.Gaidukov.
sper. teor. Fiz. (USSR), Vol. 41, No. 2(8), 354-62 (Aug., 1961).
sian.
detailed study of the galvanomagnetic properties of single-lline lead is made. The Fermi surface is constructed on the of the experimental data and is found to be double-sheeted. rt of the Fermi surface is an open surface of the type of a l cylinder net", the axes of the cylinders being parallel to the crystallographic axis; the other part is a closed surface. The es enclosed by the open and closed surfaces are equal and te (the closed surface corresponds to "holes"). The model sed here for the Fermi surface of lead is compared with the mental results on the De Haas–Van Alphen effect reported in erature. [English translation in: Soviet Physics–JETP (USA)].

465 AN INTERPRETATION OF THE CONDITIONS FOR THE EXISTENCE OF SHOCKLEY SURFACE STATES.
ecký.
J. Phys., Vol. 11, No. 8, 565-71 (1961).
study is made of the Shockley surface states in a linear of equal atoms, joined by alternately strong bonds. If the MO:LCAO method is used, which considers the exchange als between nearest neighbours and next nearest neighbours, rface states are obtained for a semi-infinite chain if the er bond is interrupted. The connection between Shockley and surface states is shown and the hypothesis is put forward e condition for the existence of Shockley surface states has rally simple physical interpretation, the validity of which is l on the models for a semi-infinite crystal so far studied.

466 ELECTRON EFFECTIVE MASS IN SOLIDS — A GENERALIZATION OF BARDEEN'S FORMULA.
ohen and F.S.Ham.
's. Chem. Solids (GB), Vol. 16, No. 3-4, 177-83 (Nov., 1960).
formula is derived for the effective mass of an electron in a l which replaces the sum over excited states in the usual sum y an integral over the surface of the unit cell. The integrand surface integral involves the wave function(s) at the symmetry or band extremum k_0 and a second solution of Schroedinger's on at the same energy but satisfying inhomogeneous boundary ions on the cell surface. The procedure is applicable regard-hether there is a degeneracy at k_0, and spin-orbit coupling e taken into account. The result thus represents a generaliza- Bardeen's formula [J. chem. Phys. (USA), Vol. 6, 367 (1948)], e effective mass of an s-band at k = 0 in the Wigner–Seitz cal approximation to an arbitrary band at any point k_0, using lyhedral cell. A related variational principle for the com- s of the effective mass matrix is also derived.

FERMI SURFACE AND THERMOELECTRIC POWER OF MONOVALENT METALS. See Abstr. 17808

FERMI SURFACE FROM THE ANOMALOUS SKIN EFFECT IN METALS. See Abstr. 17595

FERMI SURFACE AND MAGNETORESISTANCE. See Abstr. 17615

17467 INTERNAL FIELD EMISSION THEORY. G.Eilenberger.
Z. Phys. (Germany), Vol. 164, No. 1, 59-77 (1961). In German.
Internal field emission (Zener-tunnelling) is examined from two standpoints using a one-dimensional model. In the first section the transition probability is calculated using the Houston expansion, but without perturbation theory, as in previous papers by other authors. The calculation permits an examination of the various perturbation approximations. It is found that the validity of the first approximation depends critically upon the residue of the interband coupling function. This residue contains the Keldysh factor, which is determined here. In the second section the transition probability is calculated using free electron functions, again without perturbation theory. The same transition probability is obtained in both cases.

17468 THE TEMPERATURE DEPENDENCE OF THE ABSORPTION OF LIGHT BY EXCITONS. W.Biem.
Z. Phys. (Germany), Vol. 164, No. 2, 199-221 (1961). In German.
The eigenfunctions of the excitons are those of the vibrating crystal, introduced by Tyablikov, and by Lee, Low and Pines (Abstr. 4475 of 1953). The model can only be used if the coupling between excitons and crystal vibrations is weak. Expressions are derived for the production of excitons and simultaneous absorption or emission of phonons.

17469 ON THE THEORY OF EXCITONS. A.Schönhofer.
Z. Phys. (Germany), Vol. 163, No. 3, 277-92 (1961). In German.
The excited electron states of a crystal were calculated using a new type of determinant representation. For the one-electron function, this approach yields intermediate equations by the use of variational procedures, from which both the energy band states and the bound (exciton) states can be obtained. For the limiting case of very large exciton radius, hydrogen-like exciton orbits are obtained. In general a different type of spectrum is expected. The method can produce the diverse existing exciton systems (e.g. Wannier and Heller-Marcus). P.J.Dean

17470 THE SCATTERING OF FREE EXCITONS ON LATTICE DEFECTS IN MOLECULAR CRYSTALS.
A.S.Selivanenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1009-14 (April, 1961).
In Russian.
Calculations are made of the cross-section for the scattering of excitons on defects in the crystal lattice, and it is shown that for an impurity concentration of 0.01% the scattering on impurities is comparable with phonon scattering at room temperatures. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 733-6 (Oct., 1961)]. K.G.Major

17471 MICROTHEORY OF FRENKEL EXCITONS WITH AND WITHOUT DELAY. A.A.Demidenko.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1195-1210 (April, 1961).
In Russian.
A general formula is obtained for the energy bands and directions of polarization of the dipole moments of Frenkel excitons, both with and without taking delay into account, for small arbitrarily directed wave vector $\vec{k}$ in cubic crystals. The anisotropy of the effective mass is determined for longitudinal and transverse excitons. The form of the exciton energy band is found by numerical methods for symmetrical directions of $\vec{k}$ for all $|k|$. Electronic states of the subsystem are examined for fixed nuclear positions. The form of the dielectric polarization tensor $\epsilon(\omega, k)$ is found as a function of the frequency ω and wave vector $\vec{k}$. The dependence of the refractive index of the excitons on frequency is determined in the exciton absorption region. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 869-79 (Oct., 1961)].
K.G.Major

17472 EXCITONS IN CRYSTALS OF THE WURTZITE TYPE. M.Balkanski and J. des Cloizeaux.
J. Phys. Radium (France), Vol. 22, No. 1, 41-9 (Jan., 1961). In French.

A general theory of excitons is formulated from point of view of the group theory. The particular case of optical exciton formation in CdS is considered. In the simplest case, each of the three valence bands rise to one exciton series. If the complex band structure near the centre of the Brillouin zone is considered, one can show that each exciton ground state splits into a group of levels among which Γ_1 level and the two Γ_5 levels in each group can be created optically in light polarized parallel or perpendicular respectively, to the crystal axis.

17473 A THEORY OF EXCITON TRANSFER IN ANTHRACENE. K.Zalewski.
Acta phys. Polon. (Poland), Vol. 20, No. 4, 313-19 (1961).

A continuity equation describing the motion of localized excitons in an anthracene crystal is proposed. The intermolecular transition probabilities are computed in the dipole approximation with a semi-empirical adjustment, as used by Dexter (Abstr. 5404 of 1953). Simpson's experiment (Abstr. 6720 of 1957) is discussed and his phenomenological theory re-examined.

17474 EXCITON STRUCTURE AND ZEEMAN EFFECTS IN CADMIUM SELENIDE. J.O.Dimmock and R.G.Wheeler.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2271-7 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). A semi-empirical theory of exciton structure in the presence of an external magnetic field developed from Dresselhaus' effective mass approximation [J. Phys. Chem. Solids (GB), Vol. 1, 15 (1956)] was used to obtain the band parameters at K = 0,0,0 of CdSe from observed exciton spectra. The theory was approximated to the case of uniaxial crystals of small anisotropy by the assumption that the effectice mass tensor for both the hole and the electron is diagonal, the remaining anisotropy is cylindrical and small and that the anisotropy in the dielectric constant is also cylindrical and small. The exciton spectra of CdSe was observed and identified by optical reflection, absorption, and Zeeman structure at 1.8°K. The reflection and absorption spectra indicate the presence of two nonoverlapping exciton series. From observed optical selection rules, the conduction band is identified as having Γ_7 symmetry. The two series correspond to the Γ_9—Γ_7 valence band crystal field splitting of approximately 200 cm^{-1}. A third series, at higher energies, was observed in absorption corresponding to a Γ_7 valence band state split by spin—orbit effects from the other two states by approximately 3490 cm^{-1}. The n_1 = 1, 2,3, and 4 states of the first, Γ_9, series, the n_2 = 1 and 2 states of the second (first Γ_7) series, and the n_3 = 1 state of the third (second Γ_7) series were observed and identified in absorption. The series limit of the first series, corresponding to the band gap, was measured to be 14 850 cm^{-1}. The band parameters were obtained by comparing theory and experiment. The effect of the finite photon momentum was observed through changes in the Zeeman structure of the n_1 = 2, P states upon 180° rotation of the magnetic field in the plane perpendicular to the crystal C axis.

17475 EXCITON STATES AND BAND STRUCTURE IN CdS AND CdSe. J.J.Hopfield.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2277-81 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The theoretical effects of a finite slope conduction band crossing on the direct exciton energy levels of wurtzite compounds is investigated. The lack of an experimental confirmation of these effects places an upper limit of about 10^{-10} eV cm on the slope of the conduction band at k = 0 in CdS, and a slightly larger limit in CdSe. Theoretical estimates of these slopes are also calculated. Another possible method of observing the magnetic effects due to the nonzero wave vector of the excitons is noted. The striking increase of the exciton oscillator strength in CdSe in a magnetic field is attributed to the magnetic compression of the excitons. A brief comparison of experimental energy band parameters for CdS and CdSe is given.

EXCITON MOTION IN CdS. See Abstr. 17881

17476 SYMMETRY OF EXCITONS IN Cu_2O. R.J.Elliott.
Phys. Rev. (USA), Vol. 124, No. 2, 340-5 (Oct. 15, 1961).

The anisotropy of the absorption of the 1s exciton line in Cu_2O which is observed by quadrupole radiation shows that this excito is of type Γ_{25}^+. The details of the anisotropic absorption prope of the Zeeman and Stark effect are predicted and compared with experiment. The anisotropy of the indirect absorption edges al the symmetry of the phonon involved to be determined. From th symmetry identification it is possible to speculate about the nat of the valence and conduction bands in this substance. The resu appear to be in agreement with a spin—orbit valence band of Cu functions and a conduction band of Cu 4s functions. Estimates o the ortho—para exciton splitting and Stark strain splitting on thi model are of the right order of magnitude but smaller than thos observed.

THE OPTICAL LIFETIME OF THE GROUND STATE OF EXCITONS IN A Cu_2O CRYSTAL. See Abstr. 17876

17477 EXCITONS AND THE ABSORPTION EDGE OF ZnO. R.E.Dietz, J.J.Hopfield and D.G.Thomas.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2282-6 (Oct., 196

"Semiconducting Compounds" Conference Paper, Schenecta 1961 (see Abstr. 14428 of 1961). The absorption coefficient for polarized light at photon energies less than that of the lowest ly direct exciton was measured for single crystals of ZnO at temp tures ranging from 20° to 200°K. Analysis of the results shows that the absorption is in agreement with that calculated for a pr involving the simultaneous creation of an exciton and absorption a phonon, both particles having a small wave vector. The agree provides evidence that the absolute minimum of the conduction cannot lie lower than the lowest lying direct exciton level, and, therefore, that the absolute minimum probably occurs at the ce of the Brillouin zone. Values for the hole and electron masses estimated from the analysis.

17478 THE THEORY OF THE IMPURITY SCATTERING O SLOW POLARONS. Yu.E.Perlin and V.A.Kovarskii
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1031-4 (April, 1961). In Russian.

The S-wave cross-section for elastic scattering of polaron F-centres at low temperatures is calculated. The condition for resonance scattering is obtained. [English translation in: Sovie Physics—Solid State (USA), Vol. 3, No. 4, 749-51 (Oct., 1961)].
D.J.Thou

17479 POLARON BAND MODEL AND ITS APPLICATION Ce—S SEMICONDUCTORS. J.Appel and S.W.Kurnic
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2206-10 (Oct., 1

"Semiconducting Compounds" Conference Paper, Schenecta 1961 (see Abstr. 14428 of 1961). The low-lying eigenstates of th "large polarons" were calculated by several authors for arbitra strengths of the electron lattice interaction α. However, if $\alpha >$ the large polaron picture becomes questionable, since for finite temperatures the polaron eigenstates may be strongly affected b the presence of thermal phonons; then a new approach to the pol theory is applicable which takes into account the atomicity of th lattice and the presence of thermal phonons and which results i "small polaron" picture. The eigenstates of small polarons dep on T. If the eigen states form a band, the bandwidth is a functi T, and the eigenstates near the band extremum can be expresse terms of a T-dependent effective mass. From measurements o high- and low-frequency dielectric constants, of the temperatur dependence of the Seebeck coefficient, and of the electronic mob it appears that the eigenstates of the electronic charge carriers Ce—S semiconductors may be adequately described by the smal polaron picture.

17480 INSTABILITY OF ANTIFERROMAGNETIC SCREW-TYPE STRUCTURE OF AN ELECTRON GAS. A.Yoshimori.
Phys. Rev. (USA), Vol. 124, No. 2, 326-8 (Oct. 15, 1961).

An analysis of antiferromagnetic screw-type structures in three-dimensional electron gas is given, using a self-consisten field method. It is shown that a screw-type state appears to be always unstable. The expression for the susceptibility of an electron gas found by Wolff (Abstr. 17907 of 1960) is also obtai with this method.

17481 ANHARMONIC CONTRIBUTION TO THE ENERGY O DILUTE ELECTRON GAS—INTERPOLATION FOR CORRELATION ENERGY. W.J.Carr, Jr, R.A.Coldwell-Horsfall and A.E.Fein.
Phys. Rev. (USA), Vol. 124, No. 3, 747-52 (Nov. 1, 1961).

The first anharmonic contribution to the ground-state energ

dy-centred cubic lattice of electrons, oscillating in a uniform ound positive charge, is calculated. The result is $-0.73r_s^{-2}$ gs, with r_s the radius, in Bohr units, of the sphere equivalent me to that occupied per electron. Combining this term with us results gives for the ground-state energy of a dilute elec- as the expression

$$E = E_{exp} - 1.792r_s^{-1} + 2.65r_s^{-3/2} - 0.73r_s^{-2} + O(r_s^{-5/2}),$$

E_{exp} comes from the overlapping of electronic wave-functions ls off exponentially with $r_s^{1/2}$; while the r_s^{-1} and $r_s^{-3/2}$ terms spectively the Coulomb energy of a b.c.c. lattice and the zero- nergy of the electrons. The "correlation" energy correspond- the above expression, as well as the kinetic and potential parts, ted and an interpolation is made between the low-density curve e high-density expression of Gell-Mann and Brueckner. The olated curves give strong evidence that the next term in the low-density expansion for E is approximately $-0.8r_s^{-3/2}$. If h-density expression is rapidly converging near $r_s = 1$, is predicted that the r_s term in the high-density expansion approximately $-0.02r_s$.

82 THE PAIR CORRELATION FUNCTION OF AN IMPERFECT ELECTRON GAS IN HIGH DENSITIES.

. theor. Phys. (Japan), Vol. 26, No. 1, 45-50 (July, 1961).
ne pair correlation function, or the relative pair distribution n, of a high-density imperfect electron gas in the ground s computed numerically versus the distance between two ns with antiparallel spins on the one hand and with parallel n the other, for three values of density for each. In the case, it is computed, using an approximate expression, only distance which is small compared to the reciprocal of the momentum divided by ħ. In both cases it increases monoton- with distance for a value of density and decreases with density ixed distance due to the increasing effect of Coulomb repulsion ecreasing density.

HE ELECTRON-COUPLED NUCLEAR SPIN INTERACTIONS IC CRYSTALS BY THE OVERLAP MODEL.
str. 14817

83 CYCLOTRON RESONANCE IN METALS. EXPERIMENTAL. A.F.Kip.

Surface Conference Paper, Cooperstown, New York, 1960 (see Abstr. 11180 of 1961). 146-53; Disc., 174-80.
zbel'—Kaner type cyclotron resonance experiments have given ation on effective masses of electrons in tin, lead, aluminium, h, and copper. The most detailed studies have been in copper. paper the results in copper are used to illustrate the ance of several experimental parameters in identifying s types of orbits. These parameters include tipping of the tic field at small angles relative to the metal surface, and ment of the r.f. electric field either parallel or perpen- to the magnetic field. Phase shift of the cyclotron harmonics ussed. New data on copper include values for the cyclotron f the belly orbit, the dog's bone orbit, a double mass orbit, orbit which is tentatively identified as the neck orbit. s are consistent with the general shape of the Pippard model Fermi surface in copper.

84 CYCLOTRON RESONANCE. THEORY. J.C.Phillips.

Surface Conference Paper, Cooperstown, New York, 1960 (see Abstr. 11180 of 1961). 154-8; Disc. 174-80.
brief review of the Azbel'—Kaner theory of cyclotron nce in metals is given. Various corrections that have been ed to their idealized model are discussed. Diamagnetic nce effects in metals (with H normal to sample surface) are eviewed.

85 CYCLOTRON RESONANCE OBSERVATIONS IN ZINC. J.K.Galt and F.R.Merritt.

Surface Conference Paper, Cooperstown, New York, 1960 (see Abstr. 11180 of 1961) p. 159-65; Disc., 174-80.
bservations of cyclotron resonance in zinc made earlier xtended to magnetic fields of 85 kG in certain directions. and other observations were made on samples purer than used in earlier work with the result that a longer relaxation or charge carriers and therefore better resolution of the s was achieved. The results show: (1) the cyclotron mass for carriers which orbit around the hexagonal axis is about 1.3 m_0, somewhat higher than previously reported; (2) there are no carriers in zinc with masses substantially higher than these; (3) carriers of about this mass are observed with magnetic field along the [110] and [210] directions as well as the lower mass carriers previously reported.

17486 CYCLOTRON RESONANCE IN ALUMINUM. E.Fawcett.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 166-9; Disc., 174-81.

Measurements of cyclotron resonance in aluminium at 35.5 Gc/s in magnetic fields up to 30 kG failed to confirm Langenberg and Moore's observation of resonance due to a carrier of effective mass ratio 1.5 (Abstr. 13792 of 1959). A pronounced minimum of the resistance is observed at about 10 kG, over a wide range of orientations. In the absence of a further minimum at higher fields this is interpreted as the fundamental resonance of a carrier of mass ratio 0.87 ± 0.05, though the quality of the samples is too poor to show more than the first subharmonic. This value is in better agreement with the theoretical estimate for hole carriers in the second Brillouin zone obtained by Harrison (Abstr. 9887 of 1960).

17487 CYCLOTRON RESONANCE IN METALS AT HIGH FREQUENCIES. M.C.Jones and E.H.Sondheimer.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 170-3; Disc., 174-80.

The classical theory of longitudinal cyclotron resonance for an isotropic electron gas is formulated as a variational problem. A simple approximate solution is obtained, valid for

$$(l/\delta_0)^2 \ll (\omega\tau)^3, \ \omega\tau \gg 1$$

(where l is the electron free path, τ the relaxation time, δ_0 the classical skin depth and ω the applied frequency), and for all values of the applied magnetic field. The surface resistance reduces to the value obtained by Holstein (Abstr. 1556 of 1952) and Dingle (Abstr. 6787 of 1952) when $\omega_c = 0$ (where ω_c is the cyclotron frequency) and to the "classical" value when $\omega_c = \infty$, and it oscillates in the usual way as a function of ω/ω_c.

17488 INTERBAND MAGNETOREFLECTION [CYCLOTRON RESONANCE] EXPERIMENTS IN BISMUTH. R.N.Brown, J.G.Mavroides, M.S.Dresselhaus and B.Lax.

Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961), p. 203-9; Disc., 210-12.

Pulse experiments on Bi previously reported by Keyes and coworkers (Abstr. 2211 of 1957) are interpreted on a more satisfactory basis as interband transitions between magnetic levels. Further evidence for this hypothesis is provided by magnetoreflection experiments with lower steady state fields and higher photon energies. Such experiments were performed at liquid air temperatures and below, using magnetic fields up to 38.6 kilogauss and wavelengths between 6 and 14μ. The results for the mass parameters of the conduction band are found to be in agreement with those of other experiments, and for the effective g-factors in accordance with the theory of Cohen and Blount (Abstr. 16122 of 1960). This technique provides a powerful tool for exploring the energy band structure of metals not only at the Fermi surface and at liquid helium temperatures, as with other techniques but also at energies below and above the Fermi surface and at higher temperatures as well. The effective masses and also the effective spectroscopic splitting factors of the valence and conduction bands can be determined.

17489 CYCLOTRON RESONANCE IN COPPER. A.F.Kip, D.N.Langenberg and T.W.Moore.

Phys. Rev. (USA), Vol. 124, No. 2, 359-72 (Oct. 15, 1961).

Extensive cyclotron resonance experiments in copper at 24 kMc/s are described. The results are consistent with the Azbel'—Kaner theory of cyclotron resonance in metals (Abstr. 8850 of 1959) and with the known Fermi surface geometry. "Stationary" orbits (orbits having extremal effective mass and vanishing average velocity in the magnetic field direction) are found to dominate the cyclotron resonance signals in copper. The effective mass anisotropy of various classes of stationary orbits is reported. The effects of tipping the magnetic field slightly out of the plane of the sample surface and of the direction of the r.f. currents with respect to the magnetic field are described.

17490 INFRARED CYCLOTRON RESONANCE ABSORPTION IN N-TYPE GaAs.
E.D.Palik, J.R.Stevenson and R.F.Wallis.
Phys. Rev. (USA), Vol. 124, No. 3, 701-3 (Nov. 1, 1961).

Cyclotron resonance of conduction electrons in GaAs at liquid nitrogen temperature was observed in the far infrared spectral region. The data yield an effective mass ratio of 0.071 ± 0.005 at the bottom of the band.

17491 MULTICOMPONENT MAGNETOPLASMA RESONANCE IN P-TYPE GERMANIUM. R.E.Michel and B.Rosenblum.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 234-6 (Sept. 15, 1961).

At carrier concentrations high enough for the plasma frequency to be comparable to the cyclotron resonance frequency, the usual cyclotron absorption maxima are shifted by plasma effects. In p-type germanium the plasmas of the light and heavy holes form a coupled system and this produces an additional effect: on plotting the resonance lines against carrier concentration N, the absorption line which for small N corresponds to light holes moves through zero field, increases in intensity and for large N becomes the main magnetoplasma line; the heavy-hole line decreases in intensity, never passes through zero field and approaches for large N a value close to the cyclotron resonance field for light holes. Thus at each resonance there is a cooperative effect of both kinds of carriers. Theoretical curves of absorption versus static field were calculated for linear polarization, for various values of N, and found in fair agreement with experimental results. L.Pincherle

FREE CARRIER CYCLOTRON RESONANCE IN COMPOUND SEMICONDUCTORS. See Abstr. 17741

17492 CHARACTERISTIC ENERGY LOSSES IN A 20 keV ELECTRON BEAM TRANSMITTED BY A COMPOSITE FILM. F.Pradal and C.Gout.
C.R. Acad. Sci. (France), Vol. 252, No. 18, 2687-9 (May 3, 1961). In French.

The authors measured characteristic energy losses for films of CdS, CdTe, CdSe, HgTe and HgSe. The characteristic spectra of the first three differ from those of Cd, Te and Se but the spectra of HgTe and HgSe are identical with those of Te and Se. It is thought that differences in ionic radius might account for these results. A.E.I. Research Laboratory

17493 ON THE WIDTHS OF ENERGY LOSS LINES IN THE DISCRETE ENERGY LOSS SPECTRUM OF ELECTRONS PASSING THROUGH ALUMINIUM FOIL. S.Arai.
Sci. Rep. Tohoku Univ. First Ser. (Japan), Vol. 43, No. 4, 181-91 (Dec., 1961).

The energy loss line at 29.7 eV in the discrete energy loss spectrum of 20 keV electrons passing through Al foil is generally assumed to be caused by the duplicate excitation of plasma oscillation corresponding to an energy loss line at 14.8 eV, which shows angular dependency of the loss value and the intensity. The half-width of the loss line at 29.7 eV is evaluated under the assumption, taking the angular dependency of the loss line at 14.8 eV into consideration. The angular dependency of the loss value is given empirically by Watanabe (Abstr. 2177 of 1956). The angular dependency of the intensity is given theoretically by Ferrell (Abstr. 1290 of 1956; 1833 of 1958) and experimentally by Watanabe. These are considered for the present evaluation of the half-width of the loss line at 29.7 eV. The half-width evaluated is 2.31 or 2.43 (eV), which is much larger than the measured half-width 1.63 eV of the loss line at 29.7 eV. If the loss value for the loss line caused by duplicate excitation of plasma oscillation corresponding to the loss line at 14.8 eV is evaluated by using Watanabe's data, the loss value results in 29.9 eV, which is by 0.3 eV larger than the loss value 2 × 14.8 eV.

EFFECTIVE CROSS-SECTION AND ANGULAR DISTRIBUTION OF ELASTIC AND INELASTIC ELECTRON SCATTERING IN ALUMINIUM FOILS. See Abstr. 16425

17494 THE MECHANISM OF DISCRETE ENERGY LOSSES OF ELECTRONS IN GERMANIUM. N.B.Gornyĭ.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 698-700 (March, 1961). In Russian.

Curves show the relative scattering intensity as a function of the discrete energy loss, up to 36 eV, for six incident energies up to 140 eV. These were derived as previously for CdO (Abstr. 9076 of 1960). Peaks are associated with three mechanisms: excita of electron–hole pairs (1-2 eV); interband transitions (the posit agree with the calculated values) and plasma oscillations (16 eV [English translation in: Soviet Physics–Solid State (USA), Vol. No. 3, 507-9 (Sept., 1961)]. R.Be

17495 THE RANGE OF KILOVOLT ELECTRONS IN SOLI BODIES. I.M.Bronshtein and B.S.Freiman.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1122-4 (April, 1961). In Russian.

Theory has shown that the elastic scattering of electrons b solid targets increases linearly with atomic number up to Z = then shows little further increase. This is reflected in the exp mentally found range of electrons, which falls rapidly as atomi number rises from 4 to 30 then becomes relatively constant. T ratio of the range to the atomic volume of the target material i inversely proportional to the atomic number. [English translat in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 816-17 (Oct., 1961)]. A.E.I. Research Labor

17496 THE SURFACE LEVELS ON GERMANIUM DERIVE FROM PHOTOCONDUCTIVITY DATA IN THE INFRARED SPECTRAL REGION. A.V.Rzhanov and A.F.Plotnik
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1557-60 (May, 1960). In Russian.

At a temperature around 80°K, photoconductivity–wavelen curves were obtained for germanium, from λ = 1.8 to 3.4 μ. T photoconductivity was connected with the destruction, and, poss the filling up of surface levels. Two discrete levels and a syst of continuously distributed levels were observed. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5 1130-2 (Nov., 1961)]. N

17497 SOME DIFFICULTIES IN THE DYNAMICAL THEO OF ELECTRONS. A FORMALISM WHICH ATTEM TO AVOID THEM. M.Tournarie.
Bull. Soc. Franc. Mineral. Crist., Vol. 83, No. 7-9, 179-86 (Jul Sept., 1960). In French.

The difficulties in the dynamical theory of the transmissio electrons through crystals include those of writing-in the bound conditions and of choosing approximations which are workable yet realistic. For transmission through thin crystals these difficulties can be alleviated by working in a mixed matrix repr tation, direct in the direction of propagation and reciprocal in t transverse directions. In this way one can obtain rigorous sol for certain models and compare them with the results of other approximate theories. R.O.D

17498 THE THEORY OF LINEAR IRREVERSIBLE PROC IN A STRONG MAGNETIC FIELD. M.I.Klinger.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1342-53 (May, 1961). In Russian.

A theory of the transport coefficients is developed for the of a strong magnetic field and weak scattering of the electrons. Assuming weak interaction with the scattering centres, general iteration-formulae for the transport coefficients are obtained, their correctness is tested in special cases. Sometimes the iteration theory is insufficient. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 974-82 (Nov., 1961)]. N

17499 DEDUCTION OF THE QUANTUM TRANSPORT EQUATION IN A STRONG MAGNETIC FIELD.
M.I.Klinger.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1354-65 (May, 1961).

With the help of retarded Green's functions of temperature fundamental equation applying to the case of a system of electr and scattering centres placed in a strong magnetic field, is der Various applications are considered, and in particular, the cyc resonance line width. [English translation in: Soviet Physics– Solid State (USA), Vol. 3, No. 5, 983-90 (Nov., 1961)]. N

DEFECT PROPERTIES

SOME APPLICATIONS OF THE DISCRETE FOURIER
500 TRANSFORM TO PROBLEMS OF CRYSTAL LATTICE
RMATION. I. I.Babuška, E.Vitásek and F.Kroupa.
. J. Phys., Vol. 10, No. 6, 419-27 (1960).
he theory of the discrete Fourier transform is applied in
g a system of difference equations describing the positions of
in a deformed crystal lattice. The crystal lattice is approxi-
by the Born—Kármán model modified to include the internal
of the undeformed crystal.

SOME APPLICATIONS OF THE DISCRETE FOURIER
501 TRANSFORM TO PROBLEMS OF CRYSTAL LATTICE
RMATION. II. I.Babuška, E.Vitásek and F.Kroupa.
. J. Phys., Vol. 10, No. 7, 488-504 (1960).
he method elaborated in Pt I (see preceding abstract) is applied
solution of some problems for a plane lattice and the linear
The method can be used to investigate deformations around
lattice defects.

NTERRELATION OF ELECTRONIC PROPERTIES AND
CT EQUILIBRIA IN PbTe. See Abstr. 17750

ESTIMATION OF EQUILIBRIUM VACANCY
502 CONCENTRATION IN SOLID METALS.
Iehl, M.Swanson and G.M.Pound.
Metallurgica (Internat.), Vol. 9, No. 3, 256-7 (March. 1961).
semi-empirical relation is derived relating the enthalpy of
cy formation (ΔH^0) to the enthalpy of fusion ΔH_F and the
fication shrinkage $\Delta V/V$:

$$\Delta H^0 = \alpha V \Delta H_F / \Delta V$$

periment $\alpha \cong 0.40$ for close-packed metals. Hence a formula
ained for vacancy concentration (c)

$$c \cong 5 \exp(-\Delta H^0/RT).$$

A.F.Brown

RELAXATION AND ACTIVATION ENERGIES FOR AN
503 INTERSTITIAL NEUTRAL DEFECT IN AN ALKALI
DE LATTICE. R.D.Hatcher and G.J.Dienes.
Rev. (USA), Vol. 124, No. 3, 726-35 (Nov. 1, 1961).
method is developed for calculating the relaxation energy for
erstitial neutral defect in an alkali halide lattice by expanding
ectrostatic, polarization, and dipole—dipole energy contribu-
to second-order in terms of the displacements of the ions from
regular positions. The repulsive energy contributions involv-
e defect atom are treated exactly, whereas the repulsive
butions involving the regular ions themselves are also expand-
second order. This method is applied to the case of an
titial chlorine atom in NaCl for positions where the defect
is at the centre of a cube of ions and at the centre of a square
s; the difference when related to the same standard configura-
ives an activation energy of approximately 0.5 eV for the migra-
f a neutral interstitial chlorine atom in Na Cl.

STABLE ATOMIC CONFIGURATIONS FOR AN INTER-
504 STITIAL IN COPPER. K.H.Bennemann.
Rev. (USA), Vol. 124, No. 3, 669-70 (Nov. 1, 1961).
The stability of various atomic configurations for an interstitial
estigated in a model representing copper. For the interaction
en the lattice ions, a Born—Mayer and a Morse potential are
Two equilibrium configurations are found for an interstitial.
he two stable positions the formation energies and the changes
ume for the crystal arising from the interstitial are calculated.
alculations show that the crowdion and the "body-centred"
titial are unstable.

ENERGY-DEPENDENT BEHAVIOR OF INTRINSIC
505 CLOSE-PAIR DEFECTS WITHIN COPPER.
Chaplin and P.E.Shearin.
Rev. (USA), Vol. 124, No. 4, 1061 (Nov. 15, 1961).
The low-temperature substages of high-purity copper, which
ssociated with close-pair Frenkel defects, were measured
ing 2 MeV electron irradiations. Results are in the region
of multiple defect production and show that a correlation exists between prior experimental work performed by lower energy electron and 10 MeV deuteron bombardments. It is evident that each intrinsic substage possesses a very definite dependence upon irradiation energy.

THEORY OF SOLUBILITY OF INTERSTITIAL
17506 IMPURITIES IN GERMANIUM AND SILICON.
K.Weiser.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 149-61 (Dec., 1960).
A theory of solubility is developed which is based on estimating the change in energy and in entropy when an impurity is placed in an interstitial site in the lattice. Two distinct cases are considered, namely, the case of the impurity remaining electrically neutral, and the case of the impurity becoming an ionized donor. The species which results in the greater gain in free energy will be predominant in the lattice.

QUENCHED-IN DEFECTS IN TIN AND THE SUPER-
17507 CONDUCTING TRANSITION TEMPERATURE.
W.Desorbo.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 7-12 (Aug., 1960).
Wire specimens of tin quenched from a temperature T_Q ($370^\circ K < T_Q < T_{m.p.}$), exhibit a resistivity component, $\Delta\rho_o$ which disappears on annealing at lower temperatures. It is inferred that this increase in resistivity is the result of quenched-in defects. The activation energy of motion of the defects, $E_m = 0.68 \pm 0.06$ eV, while the activation energy of formation, $E_f = 0.51 \pm 0.05$ eV. The sum of these values, $E_f + E_m = Q$, is in fair agreement with the measured value of Q, the activation energy of diffusion suggesting that the imperfections are vacancies. These defects depress the resistive superconducting transition temperature by a measurable amount. The effect depends on the chemical purity of the specimen.

STORED ENERGY AND ELECTRICAL RESISTIVITY IN
17508 DEFORMED METALS.
L.M.Clarebrough, M.E. Hargreaves and M.H.Loretto.
Phil. Mag. (GB), Vol. 6, 807-10 (June, 1961).
Values for the stored energy and changes in electrical resistivity associated with the annealing of Al are presented and compared with those previously obtained for Cu, Ni and α-brass.
R.F.Peart

STORED ENERGY AND FLOW STRESS IN DEFORMED
17509 METALS.
L.M.Clarebrough, M.E.Hargreaves, A.K.Head and M.H.Loretto.
Phil. Mag. (GB), Vol. 6, 819-22 (June, 1961).
Relations between stored energy and the flow stress for a cold-worked metal are discussed. It is pointed out that theories involving piled-up groups of dislocations cannot be dismissed on the basis of measurements of stored energy and flow stress alone.
R.F.Peart

CONTRIBUTION TO THE STUDY OF CRYSTALLINE
17510 IMPERFECTIONS IN VERY PURE ALUMINIUM.
M.Wintenberger.
Ann. Phys. (France), Vol. 5, No. 9-10, 1185-1242 (Sept.-Oct., 1960).
In French.
A comprehensive study of the properties of vacancies and dislocations in 99.98-99.999% Al. Included is the influence of speed of air-and water-quenching from 600° C on the elimintation of and electrical resistivity of these defects. Electrical resistivity measurements are given for temperatures down to 2.4° K.
R.F.Peart

VACANCY TRAPPING IN QUENCHED ALUMINIUM
17511 ALLOYS. K.H.Westmacott, R.S.Barnes, D.Hull and R.E.Smallman.
Phil. Mag. (GB), Vol. 6, 929-35 (July, 1961).
Foils of some aluminium-based alloys were given various quenching treatments and the size and distribution of the vacancy clusters were observed in an electron microscope. It is concluded that the solute atoms trap the vacancies and that their binding energies determine both the scale of the clusters and the number of vacancies they contain.

THE INFLUENCE OF IMPURITY ATOMS ON THE
17512 ANNEALING KINETICS OF ELECTRON IRRADIATED
COPPER. D.G.Martin.
Phil. Mag. (GB), Vol. 6, 839-46 (July, 1961).
Spectroscopically pure copper and three dilute copper alloys

containing approximately 0.05 atomic % of silver, cadmium and beryllium respectively were irradiated with 4 MeV electrons at −196°C and then annealed at temperatures up to +50°C. The recovery of the irradiation damage was observed by measuring changes in electrical resistance, measured in liquid helium. Three annealing peaks at approximately −140°, −80° and 0°C were observed in the spectroscopically pure copper. Similar peaks occur also in the dilute alloys, but their exact form is significantly altered. A tentative explanation consistent with a widely held description of the annealing stages in irradiated copper is put forward.

17513 QUENCHING OF CATION VACANCIES IN DOPED CRYSTALS OF SODIUM CHLORIDE.
K.S.Krishnan and S.C.Jain.
Nature (GB), Vol. 191, 162-3 (July 8, 1961).

Single crystals of NaCl containing a molar concentration C of $CdCl_2$ ranging from 2×10^{-5} to 7×10^{-4} were annealed at about 1050°K and then suddenly dropped in liquid nitrogen. The electrical conductivity σ of these quenched crystals was studied. The isothermal plots of σ as a function of C were straight lines. The plot of $\log\left(\frac{\sigma T}{C}\right)$ as a function of 1/T was also a straight line. Putting $U = U_0 - \alpha T$ for the energy of activation for mobility of a sodium ion vacancy, the slope of this straight line and its intercept on the $\log\left(\frac{\sigma T}{C}\right)$ axis correspond to $U_0 = 0.85$ eV and $\exp(\alpha/k) = 460$, i.e. $-(1/U_0)(dU/dT) = 6 \times 10^{-4}$ deg^{-1}. The results point to a low value of the energy of combination of Cd^{++} and a cation vacancy in NaCl. S.C.Jain

17514 THE CREATION OF MULTIPLE THERMAL SPIKES BY RADIATION. A.Corciovei and D.Grecu.
C.R. Acad. Sci. (France), Vol. 252, No. 25, 3964-6 (June 19, 1961). In French.

A multiple thermal spike is defined as the heated region formed as a spherical layer and containing interstitial atoms produced round a "multiple vacancy" in irradiated metal. The authors calculate the mean free path (λ) of the displaced, interstitial atoms by an "impulse" technique improved to take account of the displacement of the incident atom; from the calculation the formation of multiple thermal spikes is shown to be possible. The approximate radius of the layer is calculated and the dissipation of heat from the region is assessed in terms of temperature distribution in and around the layer. J.W.Taylor

17515 OBSERVATION OF LATTICE DEFECTS IN FISSION FRAGMENT-IRRADIATED GRAPHITE.
K.Izui and F.E.Fujita.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1032-3 (May, 1961).

Briefly reports electron diffraction observations of large defects, probably due to the effects of temperature spikes, in natural graphite containing 9% uranium oxide powder after irradiation by a high flux density of thermal neutrons. C.A.Hogarth

17516 LONG RANGE EFFECTS IN THE ELECTRONIC STRUCTURE OF IMPURITIES IN METALS. A.Blandin.
J. Phys. Radium (France), Vol. 22, No. 8-9, 507-18 (Aug.-Sept., 1961). In French.

The study of the electronic structure of impurities in metals, contributes evidence of the existence of electronic density oscillations, behaving at large distances as $\cos(2k_F r + \phi)/r^3$ (in the free electron approximation). The introduction of the periodic lattice allows the results to be extended to the case of Bloch electrons. The influence of Coulomb interactions on the screening and the charge oscillations is discussed.

17517 THE DISTRIBUTION OF NICKEL IN A GERMANIUM–LEAD SYSTEM AND INTERACTION OF NICKEL WITH STRUCTURAL DEFECTS. S.G.Kalashnikov and A.K.Mednikov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 224-9 (Jan., 1961). In Russian.

Reports a determination of the partition coefficient of nickel in a system of solid germanium in contact with liquid lead at 625°-850°C. Small amounts of nickel in solid germanium affected the carrier recombination indicating that the nickel atoms interact with structural defects. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 164-8 (July, 1961)]. A.Tybulewicz

17518 SEGREGATION OF IMPURITIES IN ICE. C.Jaccard and L.Levi.
Z. angew. Math. Phys. (Switzerland), Vol. 12, No. 1, 70-6 (Jan.–1961). In German.

The distribution of impurities along a growing ice crystal calculated for an arbitrary initial distribution in the liquid, and agrees qualitatively with results obtained with hydrofluoric aci Stirring the liquid phase allows a satisfactory determination of segregation coefficient for HF, NH_3, and NH_4F as a function of concentration of the solution.

17519 IMPURITY STRIATIONS IN UNROTATED CRYSTALS OF InSb.
H.C.Gatos, A.J.Strauss, M.C.Lavine and T.C.Harmon.
J. appl. Phys. (USA), Vol. 32, No. 10, 2057-8 (Oct., 1961).

The distribution of Se (10^{18} cm^{-3} concentration) in InSb sing crystals was studied, the rotation rate being varied during cryst growth without changing the pull rate, and portions of some cry being grown without rotation. The striations, revealed by etchi longitudinal sections, showed the usual relationship between sp and rotation rate. In addition striations were observed in the unrotated portions of some crystals (not all), but no correlatio between their presence and the macroscopic conditions of cryst growth was established. The mechanisms of striation formatio in rotated and and unrotated crystals are discussed. J.B.

17520 ORIENTATION-DEPENDENT DISTRIBUTION COEFFICIENTS IN MELT-GROWN InSb CRYSTALS.
J.B.Mullin and K.F.Hulme.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 1-6 (Dec., 1960).

During the growth of InSb crystals from the melt, planar crystallographic facets can develop on the solid–liquid interfa At growth rates of 2 cm/hr the distribution coefficients for Te been shown to be different by a factor of ~ 6 on and off {111} facets — the values being ~ 3 and ~ 0·5 respectively; a simil effect has been found for a residual donor impurity. The "face effect" is not due to a solute-enriched boundary layer. The the tical significance of the results is discussed.

17521 A THEORETICAL STUDY OF POINT DEFECTS IN ROCKSALT STRUCTURE SUBSTITUTIONAL K^+ IN NaCl. J.R.Hardy.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 39-49 (Aug., 1960

A method based on lattice statics is given for studying the displacements about a substitutional potassium ion in sodium chloride. These are evaluated for certain ions close to the def and for certain specific directions at large distances from the fect. These last results are used to calculate the interaction e between a widely separated pair of defects. The correspondenc with the predictions of elastic-continuum theory is demonstrate and a method for calculating the macroscopic volume changes duced by defects is presented.

17522 ACTIVATOR DISTRIBUTION IN NaI(Tl). A.S.Kheinman.
Kristallografiya (USSR), Vol. 5, No. 6, 960-1 (Nov.-Dec., 1960) In Russian.

A discussion is given of the application of Vegard's law to lattice parameter measurements made by Runciman and Stewa (Abstr. 6656 of 1953) on NaCl(Tl) and byBuravleva et al. on Na (Abstr. 16356 of 1960). In both cases it is shown that a small of the TlCl is present other than as a substitutional solid soluti and presumably is at dislocations and block boundaries. The amounts of TlCl at such defects may be sufficient to fully acco for the luminescent behaviour of the phosphor. Some adverse comments on statements made in the latter paper are included. [English translation in: Soviet Physics–Crystallography (USA Vol. 5, No. 6, 915-16 (May-June, 1961)]. P.J

17523 THE PRODUCTION OF POINT DEFECTS BY WORK HARDENING IN A FACE-CENTRED-CUBIC METAL.
G.Saada.
Physica (Netherlands), Vol. 27, No. 7, 657-60 (July, 1961). In French.

The resistivity–strain and stress–strain curves of Pistor are compared, and the reasons for their separation, when plott in terms of defect concentration, are discussed. The measure of Pistorius on 99.999% aluminium are compared with a formul relating the concentration of point defects to the modulus of elasticity, strain and stress; the constant of proportionality is estimated. D.J.B

INFLUENCE OF DISORDER ON THE LIFETIME OF POSITRONS IN ANTHRACENE.
ini, G.Fabri, E.Gatti and E.Germagnoli.
's. Chem. Solids (GB), Vol. 17, No. 1-2, 65-8 (Dec., 1960).
he decay features of positrons in anthracene were investigated both single- and polycrystals at temperatures between C and 295° C. In solid specimens the annihilation lifetime ·7 × 10^{-10} sec independent of temperature, but very notable was found near the melting point (218°C), a complex decay ring at about 210°C. Neutron irradiated specimens showed plex decay even at room temperature.

DEFECT STRUCTURE AND PROPERTIES OF PYROLYTIC CARBONS.
lackman, G.Saunders and A.R.Ubbelohde.
Roy. Soc. A (GB), Vol. 264, 19-40 (Oct. 24, 1961).
efects were studied systematically in graphites prepared by rolysis of methane at temperatures in the range 1600° to C. Physical methods used included measurements of the lensity and studies of X-ray diffraction photographs. Electr properties examined were the electrical resistivity and gree of anisotropy, the magneto-resistance, the Hall effect, ıe thermoelectric power. The uptake of bromine to saturation ım temperature was used to characterize the structural disor- y chemical means. One main conclusion is that a striking e occurs in pyrolytic carbons as their deposition temperature s through a critical region, around 1900°C. Specimens red below this temperature have low bulk densities, show a comparatively small degree of preferred orientation, and in appreciable concentrations of residual hydrogen. Specimens ited above this temperature have bulk densities and other rties which tend towards those of perfect graphite. The al orientation improves progressively in specimens deposited 2200°C and can be brought still closer to ideal graphite by quent recrystallisation at around 2700°C. A second main g is that the α-axis thermoelectric power, whose values at temperature lead to the same general conclusions about al defects as the other methods used, shows remarkable alies as the temperature is lowered to values of reduced erature T/θ around 0·03. A preliminary examination was of changes in the anomalies resulting from crystal compound ation and from neutron bombardment. Tentative attribution se anomalies can be made to the interaction of charge carriers lattice vibrations.

17526 DYNAMICAL BEHAVIOR OF DISLOCATIONS IN ANISOTROPIC MEDIA. L.J.Teutonico.
Rev. (USA), Vol. 124, No. 4, 1039-45 (Nov. 15, 1961).
The dynamical behaviour of uniformly moving dislocations in tropic media is discussed for those crystal systems for which dge and screw components can be considered separately. ssions are obtained for the kinetic and potential energies of dge and screw dislocations. It is found that screw dislocations e normally at all velocities up to the limiting velocity. Edge cations, however, display an anomalous dynamical behaviour. ears that in general there is a range of velocities for which ear stress on the slip plane is negative and edge dislocations e sign attract rather than repel one another. In an isotropic ial the upper limit of this velocity range is the velocity of sound; the lower limit is the Rayleigh wave velocity which ever be less than 0.69 the velocity of shear sound. In the tropic case it is possible for the limiting velocity (for a given tation) to be less than the corresponding shear wave velocity; he threshold velocity for the anomalous dynamical behaviour e any velocity from zero up to the shear wave velocity, ding on the elastic constants of the material and the orientation dered. An example of an edge dislocation in a hexagonal ial is discussed in some detail.

17527 INTERACTION OF DISLOCATIONS, COLD-WORKING AND PRODUCTION OF POINT DEFECTS IN F.C.C. ALS. G.Saada.
metallurgica (Internat.), Vol. 9, No. 2, 166-8 (Feb., 1961).
ench.
A theoretical formula was derived for σ_i, the temperature-endent part of the flow stress in Seeger's theory of work-ning:

$$\sigma_i = (\mu b/\beta)\rho_D^{1/2}$$

lastic modules, b = Burger's vector, ρ_D = density of dislocations). Theory gives $\beta = 4$. Experimental data from a variety of sources, by various methods and for various f.c.c. metals are analysed to show that there is good agreement with the theory. The number of point defects (dn) created by extension $d\epsilon$ is given by the theoretical formula

$$dn = (A/\mu b^3)\sigma\, d\epsilon$$

(σ = applied stress) where theory gives $A = \frac{1}{4}$. The available experimental data are in agreement with this formula.
A.F.Brown

17528 THE STRESS FIELD OF AN INFINITE EDGE DISLOCATION WALL. J.C.M.Li.
Acta metallurgica (Internat.), Vol. 9, No. 4, 384-5 (April, 1961).
The equations for the normal stresses due to an infinite edge dislocation wall, given by Amelinckx and Strumane, are incorrect. The equations and their graphical representations are corrected, and equations for all the short-range stresses due to such a wall are presented in a different form. It is suggested that, in practice, polygonization is controlled by the long-range stresses of a partially polygonized wall. D.J.Barber

17529 THE FORMATION OF DISLOCATIONS BY A SPARK DISCHARGE. B.Šesták and S.Libovický.
Czech. J. Phys., Vol. 10, No. 10, 759-64 (1960).
The arrangement of dislocations formed in a single crystal of the alloy Fe—4.2% Si by a spark discharge in air is studied. The dislocations are made visible by etching on the surfaces perpendicular and parallel to the axis of the crater. The results of the observations are explained on the basis of microphysical conceptions of plastic deformation.

17530 ELASTIC STRESS AROUND LINEAR DISLOCATION IN ANISOTROPIC MEDIUM. J.Kratochvíl.
Czech. J. Phys., Vol. 11, No. 5, 324-35 (1961).
Relations are derived for the elastic stress field around a linear dislocation in an infinite medium with general anisotropy. The strongly deformed material around the core of the dislocation is cut out in the shape of an elliptic cylinder. The conditions of a free surface are used on the boundary thus formed. The calculations of the field around a crack in a crystal, the model of which was proposed by Fujita, is given as an example.

17531 THE PRODUCTION OF DISLOCATIONS BY ELECTRIC EROSION OF SINGLE CRYSTALS.
L.S.Palatnik, A.A.Levchenko and V.M.Kosevich.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 96-9 (May 1, 1961). In Russian.
For abstract, see Abstr. 14282 of 1961. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 418-21 (Oct., 1961)].

DISLOCATION RELAXATION AT HIGH FREQUENCIES.
See Abstr. 17407

17532 INVESTIGATIONS OF DISLOCATIONS IN SINGLE CRYSTAL AND POLYCRYSTALLINE PLATES OF AgCl. L.Malický.
Czech. J. Phys., Vol. 11, No. 2, 141-3 (1961). In German.
The dislocation densities were determined optically on planes [100], [110], and [111] as a function of pressure (up to 900 kg/cm²). In the range investigated, at room temperature, the densities increased by an order of magnitude 1-2; the newly formed crystals showed density variations from 10^4 to 10^6/cm². F.Ansbacher

DISLOCATIONS IN GERMANIUM DENDRITIC RIBBONS.
See Abstr. 15009

17533 DISLOCATION RELAXATION IN SILVER, GOLD, PALLADIUM AND PLATINUM.
P.G.Bordoni, M.Nuovo and L.Verdini.
Nuovo Cimento Suppl. (Italy), Vol. 18, No. 1, 55-88 (1960).
A large amount of experimental evidence is compiled in order to analyse factors influencing dislocation relaxation. Results of measurements of energy dissipation and resonant frequencies as a function of temperature are given for circular polycrystalline metal plates. The existence of dissipation peaks and subsidiary peaks is discussed in the light of present theories of dislocation motion. Activation energy and characteristic time is considered together with relaxation spectra, frequency relaxation and the

influence of thermal and mechanical treatment of the samples. The authors arrive at the following conclusions. The motion of the dislocations seems to be independent of impurity content of the samples investigated. There is satisfactory agreement between experiment and theory for the activation energy but not for the characteristic time. The asymmetry of the dissipation peak is possibly due to the presence of subsidiary peaks on the low temperature side of the main peak. Recrystallization effects are reported to be probably responsible for temperature-independent frequency shifts in thermally and mechanically treated samples.

W.G.Mayer

17534 THE EFFECT OF MICROSEGREGATION ON THE GENERATION OF DISLOCATIONS IN ZINC SINGLE CRYSTALS. P.Kratochvíl.
Czech. J. Phys., Vol. 10, No. 12, 927-30 (1960).

The applicability of Tiller's considerations on the production of dislocations is proved. The density of dislocations appearing during impurity microsegregation increases with increasing rate of growth as a consequence of the corresponding change in the effective distribution coefficient. The real value of ΔC at the microsegregation boundaries is at least twice as great as the average value of the concentration of impurities in the crystal in question.

17535 DISLOCATION RELAXATION IN ZINC AT LOW TEMPERATURES. B.K.Agrawal and G.S.Verma.
Proc. Phys. Soc. (GB), Vol. 77, Pt 6, 1216 (June, 1961).

A mechanism to explain the properties of the Bordoni peak recently observed in zinc is given. The activation energy values are: 0.33 eV (experimental) and 0.303 eV (theoretical).

C.A.Hogarth

DISLOCATION DISTRIBUTION IN PLASTICALLY DEFORMED Zn. See Abstr. 14880

17536 ELECTRON SPIN RESONANCE STUDIES OF IMPURITY IONS IN MAGNESIUM OXIDE.
J.W.Orton, P.Auzins, J.H.E.Griffiths and J.E.Wertz.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 554-68 (Oct., 1961).

The univalent ions Fe^+, Co^+ and Ni^+ were produced by ultraviolet or X-irradiation of impure MgO crystals. The electron spin resonance spectra of these ions are compared with those of the isoelectronic Co^{2+}, Ni^{2+} and Cu^{2+} which they resemble closely. The spectra of Fe^+, Co^+ and Ni^+ show line-width effects which may be interpreted as being due to the presence of small distortion in the cubic crystal lattice. A detailed report of the $3d^9$ configuration in a cubic field is given. There is a transition at low temperature from an isotropic to an anisotropic spectrum presumably due to the "freezing in" of Jahn–Teller distortions. Observation of hyperfine structure from Ni^{61} made it possible to estimate the nuclear moment by comparison with the observed hyperfine structure from Co^+. The ease of formation and stability of these univalent ions is shown to be related to the concentration of positive ion vacancies and to the concentration of trapped hole centres.

17537 X-RAY INVESTIGATION OF DISTURBANCE FIELDS DUE TO INDIVIDUAL DISLOCATIONS IN Si AND Ge.
J.Auleytner.
Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 371-7 (1961).

A rather simple method of X-ray detection of disturbance fields from individual dislocations on silicon and germanium crystal surfaces, using a divergent beam from an X-ray point focus and a spectrometer with oscillating film parallel to the crystal surface, is described. X-ray mapping of the surface and optical mappings are compared. Linear dimensions of the disturbance fields, in the case of a silicon single crystal with a density of less than 10^4 dislocations per cm^2, were found to range from 20 to 120 μ. The increase of intensity of the diffracted X-ray beams within the disturbance regions was measured, and a discussion of the contribution therefrom to the intensity of the G.-M. counter recorded reflections is given for the case of a double-crystal spectrometer.

17538 THE EFFECT OF ORDERING ON THE STRENGTH AND DISLOCATION ARRANGEMENTS IN THE Ni_3Mn SUPERLATTICE. M.J.Marcinkowski and D.S.Miller.
Phil. Mag. (GB), Vol. 6, 871-93 (July, 1961).

The dislocation configurations in thin foils of Ni_3Mn were examined by transmission electron microscopy for various intermediate states of long-range order as well as for complete long-range disorder. It was found that, as long-range order comme pairs of ordinary dislocations, i.e. superlattice dislocations, a formed. The spacing between these pairs decreases as the ord becomes more perfect. Due to its relatively low stacking-fault energy, a high density of stacking-fault ribbons was found to be present in the disordered alloy. Upon ordering, however, these faults are completely eliminated. This behaviour was associat with an effective increase in the stacking-fault energy due to lo range order. In addition, measurements of the flow stress sho pronounced increase in strengthening for the intermediate state of order. This behaviour was discussed in conjunction with the present theories of order strengthening, all of which fail in one or another to account suitably for the observed results. Anothe mechanism was proposed which is associated with the destruct of the component of short-range order co-existing with long-ra order, and is found to account qualitatively for the present resu

17539 REVEALING THE EMERGENCE OF DISLOCATION THE SURFACE OF A CRYSTAL BY THE ETCH METHOD. V.R.Regel', A.A.Urusovskaya and V.N.Kolomiichuk Kristallografiya (USSR), Vol. 4, No. 6, 937-55 (Nov.-Dec., 1959 In Russian.

A comprehensive review is made of theoretical and experi mental work on the chemical and thermal etching of dislocation which has been published in the last decade. The findings of th more important papers are summarized and their implications are discussed, but no illustrations are included, as these are considered to be easily accessible elsewhere. Dislocation etch for semiconductors, metals, alloys, ionic solids and minerals a tabulated, with appropriate references. Finally, recent Russia contributions to the subject are described briefly. [English tra lation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 6 895-917 (June, 1960)]. D.J.B

17540 THE MOVEMENT OF DISLOCATIONS IN CRYSTAL ANTIMONY. L.M.Soifer and V.I.Startsev.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1084-7 (June 11, 1961) In Russian.

Dislocations in antimony were studied by an etch-pit meth Wedge-shaped tracks indicated the paths of moving dislocations the tracks terminated in pointed pits, corresponding to arrest positions. The distance between arrest points was less than 10 The dislocation velocity was between 1.10^{-4} and 3.10^{-5} cm sec^{-1} Wide double traces (width ~30 μ) contained a linear density of pits ~5.10^1 cm^{-1}, whilst narrow double traces (width ~5 μ) had density ~10^3 cm^{-1}. The traces were believed to correspond wi dislocation loops involved in slip processes. From the apparen operation of dislocation sources, it was concluded that Cottrell atmospheres were not present. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 6, 457-9 (Dec., 1961)].

D.J.Bark

17541 SOME METALLOGRAPHIC OBSERVATIONS ON Ge SINGLE CRYSTALS WITH SMALL DENSITY OF ED DISLOCATIONS. A.Hrubý.
Czech. J. Phys., Vol. 10, No. 10, 767-8 (1960).

It has been reported by Tweet (Abstr. 1588 of 1960) that accelerated etching takes place in the centre of the face of a Ge single crystal which has a very low density of edge dislocations also that small etch pits characteristic of vacancies are observ The author investigates these phenomena further and notes that the presence of accelerated etching is dependent upon the meth growth of the crystal. It is observed too, that the fine etch pits occur not only in crystals with low dislocation density but also crystals with a density of the order of 1000 cm^{-2}. A.

17542 OBSERVATION OF DISLOCATIONS IN GERMANIUM SINGLE CRYSTAL.
M.Shoji, S.Tauchi, T.Mitsuishi and M.Tomono,
J. Phys. Soc. Japan, Vol. 16, No. 6, 1253 (June, 1961).

A large discrepancy exists in the observed etch pit densiti germanium between a CP-4 etch and a slow etch. X-ray observ tions on a number of specimens show that the large etch pit den obtained using the slow etch never corresponds to the usual dis tion line density, and that some other defect must be the cause these etch pits. B.R.Hol

543 DISLOCATIONS IN FERROELECTRIC GLYCINE SULPHATE SINGLE CRYSTALS. H.Toyoda.
ys. Soc. Japan, Vol. 15, No. 8, 1539 (Aug., 1960).
Effects of etching with alcohol (slow) or water (fast) are ribed. Patterns due to domain structures and to dislocations e distinguished. C.A.Hogarth

544 DISLOCATIONS, STACKING FAULTS AND TWINS IN THE SPINEL STRUCTURE. J.Hornstra.
ys. Chem. Solids (GB), Vol. 15, No. 3-4, 311-23 (Oct., 1960).
The slip plane in crystals of the spinel type is assumed to be the plane in analogy with the basal slip of corundum. This is also reement with experimentally observed deformation twinning, n may be explained as a mechanism involving partial disloca- with a (111) slip plane. Dislocations with a (111) slip plane consist of four partial dislocations separated by three stacking s. The detailed structure of these stacking faults is compared the perfect spinel lattice. During slip the cations move in a tion different from that of the oxygen ions. This process, the ıro-shear process, is discussed for the case that cations with old coordination take part in it. Another type of stacking fault s relationship to the olivine lattice. Two possible configura- of the (111) twin boundary are discussed.

545 STACKING FAULTS IN IRON—MANGANESE AND COBALT—NICKEL. J.Spreadborough.
cryst. (Internat.), Vol. 13, Pt 8, 603-5 (Aug., 1960).
The results of applying the method which may be used to ure the fault parameters in hexagonal and cubic materials are ented and discussed for a cobalt—nickel alloy. Studies of -manganese alloys show that the epsilon phase faults readily; factor may contribute to the high work-hardening capacity of alloys.

546 X-RAY MEASUREMENT OF STACKING FAULT WIDTHS IN F.C.C. METALS. B.E.Warren.
pl. Phys. (USA), Vol. 32, No. 11, 2428-31 (Nov., 1961).
A generalized derivation of the broadening of powder pattern by stacking faults was carried through allowing for fault planes bitrary dimensions. A minimum dimension for the fault plane is obtained from the measurable effective particle-sizes 11) and $D_e(200)$. Values of T_{min} of the order of 200 A are ned for samples of filings of copper, α-brass, and silver. results suggest that, in the drastic cold work involved in gs, the stacking faults tend to extend over rather large distances parable to the coherent domain dimensions.

547 X-RAY INVESTIGATION OF STACKING FAULTS IN DEFORMED TANTALUM.
Muravtsov and B.I.Smirnov.
tverdogo Tela (USSR), Vol. 3, No. 4, 1272-6 (April, 1961).
ssian.
The dependence of effective block size in tantalum filings on tation was investigated by examining the 110, 200, 211, 220, nd 422 X-ray reflections. The size of the blocks was found to 110) = 210 A, D(100) = 120 A, D(211) = 130 A. The results are pared with data from other body-centred cubic metals. [English lation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 3 (Oct., 1961)]. R.F.S.Hearmon

RECRYSTALLIZATION GRAINS IN DEFORMED NaCl.
Abstr. 14874

548 INVESTIGATIONS IN THE FIELD OF CRYSTAL CERAMICS. II. THE INFLUENCE OF HYDROSTATIC SSURE ON THE KINETICS OF HEALING OF MACRODEFECTS ONIC CRYSTALS. Ya.E.Geguzin and L.M.Polyakov.
tverdogo Tela (USSR), Vol. 3, No. 2, 520-7 (Feb., 1960).
ssian.
For previous work see Abstr. 4024 of 1961. Observations of scattering in single-crystal NaCl at hydrostatic pressures up to m are made to assess the effect of pressure on the accelera- of healing of defects. The observations are explained in terms diffusion mechanism and of the effect of pressure on the concen- on and gradient of defects. Under given conditions the same ng effect can be realized by increasing either the pressure or emperature. [English translation in: Soviet Physics—Solid (USA), Vol. 3, No. 2, 381-6 (1961)]. R.F.S.Hearmon

Diffusion

17549 DETERMINATION OF THE COEFFICIENTS OF DIFFUSION IN ALLOYS. I.V.Smushkov.
Fiz. Metallov i Metallovdenie (USSR), Vol. 10, No. 2, 313-16 (Aug., 1960). In Russian.

It is shown analytically that failure to take into account the concentration-dependence of the diffusion coefficient, D, may lead to large errors when D is determined by the radioactive tracer technique, used in conjunction with the solution of the diffusion equation $\partial c/\partial t = D\partial^2 c/\partial x^2$, which is valid only if $\partial D/\partial c$ is very small. A method of overcoming this difficulty is suggested. M.H.Sloboda

17550 THE PROBLEM OF DIFFUSION IN AN EVAPORATED SOLID MEDIUM. T.I.Kucher.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 547-52 (Feb., 1961). In Russian.

An exact solution of the diffusion problem is attempted and two families of curves of the variation of relative concentration of the diffusing substance obtained. These curves may be compared with experiment to give values of various diffusion parameters. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 2, 401-4 (1961)]. K.N.R.Taylor

17551 ON THE LOCATION AND MOTION OF RARE GAS ATOMS IN METALS. C.W.Tucker, Jr and F.J.Norton.
J. nuclear Materials (Internat.), Vol. 2, No. 4, 329-34 (Dec., 1960).

Using potentials of about 40 kV, rare gas ions were accelerated into metal films and foils. In spite of the fact that as much as 2 at.% argon was loaded into the metal lattice, little or no X-ray effect due to lattice distortion was observed. This result suggests that rare gas atoms coming to rest in a metal lattice capture vacancies. When rare gas loaded metal foils are heated in a vacuum system connected to a mass spectrometer, the evolution of the gas can be measured. The evolution of argon from foils of silver, gold, aluminium and lead, and krypton from uranium was studied with interesting variations from metal to metal. Exploratory experiments with other rare gases indicate similar results. The combination of the ion bombardment and mass spectrometer techniques appears very promising for the study of the behaviour of rare gases in crystals.

17552 DIFFUSION OF ALUMINIUM, TIN, VANADIUM, MOLYBDENUM, AND MANGANESE IN TITANIUM.
D.Goold.
J. Inst. Metals (GB), Vol. 88, Pt 10, 444-8 (June, 1960).

The influence of temperature and concentration on the diffusivity of substitutional elements in β-titanium has been assessed. The diffusivity of tin and aluminium in α-titanium at one and two temperatures, respectively, has also been determined. Movement of thoria markers at the interface between titanium and titanium alloys during diffusion at a single temperature in the β phase has been measured, and from the results partial diffusivities of the alloying elements have been calculated by the method of Darken [Transactions of the American Institute of Mining and Metallurgical Engineers, 175, 184 (1948)].

17553 DETERMINATION OF THE DIFFUSION COEFFICIENT OF ARSENIC IN GERMANIUM BY MEASUREMENT OF THE THERMOELECTRIC VOLTAGE.
E.Batifol and G.Duraffourg.
J. Phys. Radium (France), Vol. 21, Suppl. No. 11, 207A-216A (Nov., 1960). In French.

The diffusion coefficient was deduced from the measurement of thermoelectric power along a bevelled sample of As-diffused germanium. The As surface concentration was obtained both by the measurement of thermoelectric power and by the measurement of sheet resistance; the average value of the As diffusion coefficient at 800°C is $D = 1.3 \times 10^{-11}$ cm^2 sec^{-1}.

17554 NOTE ON SOLUTE DIFFUSION IN FACE-CENTERED CUBIC METALS. S.Ohh.
Acta metallurgica (Internat.), Vol. 9, No. 4, 387-8 (April, 1961).

Available data on diffusion of solutes in copper are used to plot logarithms of the solute diffusion coefficients at the melting point of the solvent, D_m^1, against the square of the melting points T_{mi} of the solutes. The points fall approximately along a straight line. From the straight line the values of the constants α and γ_o

in the relation $D_m^i = \gamma_0 \exp(-\alpha T_{mi}^2)$ are 8.3×10^{-7} °K^{-2} and 3.8×10^{-8} cm^2 sec^{-1}. The value of γ_0 for diffusion in copper is the same as that for diffusion in nickel or silver. S.C.Jain

ELECTRICAL MIGRATION OF IRON AND ALUMINIUM IN IRON–ALUMINIUM ALLOYS. See Abstr. 15163

17555 DIFFUSION WITH A CONCENTRATION DISCONTINUITY: THE HYDROGEN–PALLADIUM SYSTEM.
R.Ash and R.M.Barrer.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 246-52 (Nov., 1960).

A treatment is given of diffusion through membranes of a material in which the solute dissolves to give two non-stoichiometric phases with a concentration discontinuity between them. Such systems include hydrogen in palladium and in other transition metals. It is shown how the discontinuity which appears in the concentration gradient modified the determination of diffusion coefficients by permeability or time-lag measurements.

17556 SELF DIFFUSION IN IRON.
F.S.Buffington, K.Hirano and M.Cohen.
Acta metallurgica (Internat.), Vol. 9, No. 5, 434-9 (May, 1961).

Self-diffusion in high-purity iron (99.97% Fe) was determined over the temperature range 700° to 1436°C. The temperature dependence of the self-diffusion coefficient in face-centred cubic and in body-centred cubic iron can be expressed as follows (in cm^2/sec):

Gamma-iron:	$D = 0.18 \exp(-64\,500/RT)$
Alpha-iron (paramagnetic):	$D = 1.9 \exp(-57\,200/RT)$ (above 790°C)
Alpha-iron (ferromagnetic):	$D = 2.0 \exp(-60\,000/RT)$ (below 750°C).

The diffusivity below the magnetic transformation is lower than expected from an extrapolation of the diffusion data for paramagnetic alpha-iron.

17557 DIFFUSION IN MULTIPHASE SYSTEMS.
Bao-Syué-Sin' [Pao-Hsüeh-Hsin], B.S.Bokshtein and A.A.Zhukhovitskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 723-8 (March, 1961).
In Russian.

The self-diffusion of iron in two-phase iron–copper alloys was studied by a slicing technique. It is shown that the addition of a small quantity of a phase, having a lower mobility, causes a sharp reduction in the effective diffusion ceofficient of the alloy. The addition of a phase characterized by a higher mobility was less effective in changing the diffusion coefficient. On the basis of an analogy with the electrical conduction in binary metallic alloys, a formula connecting the coefficients of diffusion for individual phases and multiphase systems is derived and compared with the results of experiment. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 3, 527-30 (Sept., 1961)].
D.J.Barber

17558 DIFFUSION OF NEON ISOTOPES IN FUSED QUARTZ.
R.C.Frank, D.E.Swets and R.W.Lee.
J. chem. Phys. (USA), Vol. 35, No. 4, 1451-9 (Oct., 1961).

The diffusion of Ne^{20} and Ne^{22} through the walls of high-purity fused quartz hollow cylinders was studied using a mass spectrometer as a detecting device. The diffusion process was found to be relatively simple and fairly well described by Fick's laws. Diffusion coefficients and permeabilities were measured for both isotopes in the temperature range of 440° to 985°C. The D_0's for Ne^{20} and Ne^{22} were $(2.21 \pm 0.12) \times 10^{-4}$ cm^2/sec and $(2.08 \pm 0.17) \times \times 10^{-4}$ cm^2/sec respectively. The activation energy for diffusion for Ne^{20} was 11 370 ± 80 cal/g atom and the value for Ne^{22} was found to be statistically equivalent to this. The best estimate of the ratio of the D_0's was 1.05 ± 0.01. Solubilities were calculated by dividing the permeabilities by the diffusion coefficients. The heats of solution for the two isotopes were the same and equal to −1950 ± 150 cal/g atom. The significance of the isotope effect in diffusion is discussed.

17559 DIFFUSION OF NICKEL INTO IRON.
K.Hirano, M.Cohen and B.L.Averbach.
Acta metallurgica (Internat.), Vol. 9, No. 5, 440-5 (May, 1961).

The diffusion was measured in the temperature range 600°-1050°C. Radioactive Ni^{63} was used as the tracer element surface-decrease and the residual-activity sectioning methods employed. The diffusivity below the Curie temperature was observed to be lower than that expected from an extrapolation diffusion data for paramagnetic alpha-iron. The diffusion coefficients may be expressed as follows (in cm^2/sec): Gamma-iron $D = 0.77 \exp(-67\,000/RT)$; Paramagnetic alpha-iron above 800 $D = 1.3 \exp(-56\,000/RT)$; Ferromagnetic alpha-iron below 680 $D = 1.4 \exp(-58\,700/RT)$. The anomalous decrease in the diffu coefficient starts at about 800°C, somewhat above the Curie temperature, and is thought to be associated with the effect of short ra magnetic order on the formation energy of vacancies.

17560 THE DIFFUSION OF OXYGEN IN SILICON AND GERMANIUM. C.Haas.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 108-11 (Aug., 19

Using a simple model for the structure of oxygen in silicon germanium crystals and making the assumption that internal f tion and diffusion are both due to the same relaxation phenome the diffusion coefficient of oxygen is calculated from experime data on internal friction. The results are: $D = D_0 \exp - (U/k$ O in Si: $D_0 = 0{\cdot}21$ cm^2/sec, U = 2·55 eV; O in Ge: $D_0 = 0{\cdot}17$ c U = 2·02 eV. The calculated values of D are in reasonable agr ment with available experimental data.

17561 PLUTONIUM–ALUMINUM SOLID SOLUBILITY A DIFFUSION STUDIES. A.E.Hall.
Nuclear Sci. Engng (USA), Vol. 8, No. 4, 283-8 (Oct., 1960).

The solid solubility and diffusion of plutonium in aluminiu were studied at 600°C. Cylindrical diffusion couples were pre ed by coextrusion, and consisted of a core of 7 weight % pluto 93% aluminium alloy clad with aluminium. Quantitative autorad graphy was utilized to determine the solid solubility, while metallographic measurement furnished data for calculation of diffusion coefficient.

17562 A STUDY OF THE SURFACE STATES OF A KCl S CRYSTAL EXPOSED TO POTASSIUM VAPOUR.
H.Mizuno and S.Miyamoto.
Physica (Netherlands), Vol. 27, No. 8, 800-8 (Aug., 1961).

It is shown that in additive colouring processes there exis rate limitation for the diffusion of potassium atoms at the surf a KCl single crystal. The constant which is characteristic for rate limitation and the diffusion coefficient of Cl ions were me as a function of temperature. An energy barrier to be overcon a potassium atom at the surface of a KCl single crystal is sug to explain the experimental results.

17563 DIFFUSION OF RADON IN OXIDES BY RECOIL LABELLING. R.Lindner and H.Matzke.
Z. Naturforsch.(Germany), Vol. 15a, No. 12, 1082-6 (Dec., 196
In German.

The diffusion of radon in the oxides of aluminium, titaniu thorium, and uranium was measured. The activation energies gas diffusion at higher temperatures were between 40 and 70 kcal/mole. R.Schnu

17564 PENETRATION OF SILVER INTO RUTILE AND PEROVSKITE CERAMICS.
R.Sh.Malkovich and M.A.Afanas'eva.
Fiz. tverdogo Tela (USSR), Sbornik[Supplement] II, 291-5 (195
In Russian.

Penetration of silver into T-80 (a rutile ceramic with 88% and T-150 (a perovskite ceramic consisting of $CaO.TiO_2$ with 1% ZrO_2) was studied at temperatures up to 720°C, both with without the application of electric fields. The conditions for b silver-paste electrodes were also investigated. It was found th silver diffused faster in T-80 than in T-150. In both cases, dif occurred mainly along grain boundaries. In electric fields, the silver was transported towards the cathode, indicating that it present in the form of positive ions. When the anode was mad silver, penetration in electric fields was considerable; this ma account for lowering of the breakdown voltages in ceramic cap ors with silver electrodes. A.Tybu

17565 DIFFUSION OF ZINC IN GALLIUM ARSENIDE. F.A.Cunnell and C.H.Gooch.
Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 127-33 (Aug., 1960).
The diffusion of zinc into gallium arsenide from the vapour se was investigated for a range of diffusion temperatures and c pressures. Experiments to investigate the influence of arsenic ssure on the diffusion were also performed. The results ined depart radically from those expected for a constant diffusion fficient; possible reasons for this are discussed.

17566 THE DIFFUSION OF IONIZED IMPURITIES IN SEMICONDUCTORS. J.W.Allen.
Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 134-9 (Aug., 1960).
The diffusion coefficient of an impurity in a semiconductor ends on the state of ionization of the impurity, i.e., on whether Fermi level lies above or below the impurity energy level. imple model, namely the one-dimensional diffusion of a shallow eptor, is used to illustrate this and the results are applied to diffusion of zinc in gallium arsenide (see preceding abstract).

17567 SELF-DIFFUSION IN BODY-CENTERED CUBIC ZIRCONIUM. G.Kidson and J.McGurn.
ad. J. Phys., Vol. 39, No. 8, 1146-57 (Aug., 1961).
Self-diffusion coefficients of crystal-bar zirconium were asured between 1500°C and 1100°C, using radioactive Zr^{95} as racer. The results may be represented by

$$D = 2.4 \times 10^{-4} \exp - \left[\frac{30\,100}{RT}\right] \text{ cm}^2/\text{sec.}$$

e pre-exponential factor is about three orders of magnitude aller than that measured in most close-packed systems and the vation energy about one-half that anticipated from an empirical relation with the melting point. The results, however, are ilar to those of a few other recently studied body-centred cubic tems, and agree quantitatively with work in the Soviet Union on conium. There is considerable evidence that the diffusion cess occurs via vacant lattice sites.

17568 ON A METHOD OF DETERMINATION OF THE COEFFICIENT OF THERMAL DIFFUSION OF METALS SEMICONDUCTORS. J.Oualid.
hys. Radium (France), Vol. 22, No. 2, 124-6 (Feb., 1961).
rench.
The theory and technique of a thermal shock method are cribed. A brief thermal shock of about 0.1 sec is applied by high-uency induction, and this provides an accurate (better than 5%) simple method for the measurement of the coefficient of thermal sion. J.B.Birks

lour Centres

17569 STUDIES OF COLOR CENTERS PRODUCED IN APATITE HALOPHOSPHATES BY SHORTWAVE ULTRA-- DLET RADIATION. L.Suchow.
Electrochem. Soc. (USA), Vol. 108, No. 9, 847-51 (Sept., 1961).
An investigation was made of the effects of shortwave ultra-let radiation on nonluminescent base materials in which it is sible to isolate other electronic processes from those of lumin-ence. This radiation was found to produce colour centres in a cal commercial halophosphate base material, in a similar pre-ation with manganese present in addition, and also in compounds solid solutions in the systems $Ca_5(PO_4)_3F$–$Ca_5(PO_4)_3Cl$, $(PO_4)_3F$–$Sr_5(PO_4)_3Cl$, and $Ba_5(PO_4)_3F$–$Ba_5(PO_4)_3Cl$. All colours may bleached thermally and some optically as well. In preparations taining strontium, thermal bleaching is accompanied by lumin-ence, and glow curves were measured. Optical bleaching is ompanied by luminescence.

17570 COLORING OF IONIC CRYSTALS BY ELECTRON BOMBARDMENT. Y.Igarashi.
. Elect. Commun. Lab. (Japan), Vol. 8, No. 12, 1-6 .-Feb., 1961).
A study was made of the colouring due to the bombardment of porated films and single crystals of NaCl with 600 V electrons. ew optical absorption band ~ 1.1 μ was found, which was connect-vith the surface structure. Thermal as well as optical ching behaviour was examined.

PHOTOCAPACITANCE EFFECTS IN ADDITIVELY COLOURED ALKALI HALIDE CRYSTALS. See Abstr. 17828

17571 COLOUR CENTRE IN $BaTiO_3$ SINGLE CRYSTALS. V.Dvořák.
Czech. J. Phys., Vol. 11, No. 4, 253-60 (1961).
The position of the absorption band of a colour centre formed by one electron trapped on an oxygen vacancy, in a cubic modification of $BaTiO_3$ single crystals, is quantum mechanically calculated.

17572 ON THE REVERSIBLE OPTICAL CONVERSION BETWEEN A- AND B- CENTRES IN COLOURED KCl CRYSTALS. H.Ohkura and T.Uchida.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2114-15 (Nov., 1960).
This reversible transition, observed at -180°C, is temperature sensitive and does not occur at -200°C. J.E.Caffyn

17573 NATURE OF A-CENTRES IN KCl. N.Nishimaki, K.Kojima and T.Kojima.
J. Phys. Soc. Japan, Vol. 16, No. 3, 576-7 (March, 1961).
An enhanced A-band was found in quenched additively coloured KCl crystals containing 1 mol.% NaCl, and it is proposed that the A-centre is an F-centre adjacent to a substitutional Na ion. This model predicts that the A-band has dichroic properties and experimental evidence for this is presented. J.E.Caffyn

17574 TEMPORARY BLEACHING OF COLOR CENTERS IN KCl CRYSTAL. M.Hirai, M.Ikezawa and M.Ueta.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1477-8 (July, 1961).
F-band irradiation at 90°K causes a temporary change in the absorption spectrum of additively coloured crystals, if the crystals are previously irradiated with F-band light at room temperature to produce M, N and R centres. It is concluded that electrons are trapped in M and N centres to form M' and N' centres which are unstable at 90°K. G.F.J.Garlick

17575 THE COMPLEX NATURE OF THE F-BAND IN KCl CRYSTALS. N.G.Politov.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 173-6 (Feb., 1961).
In Russian.
Experimental data are presented indicating the complex nature of absorption and phosphorescence excitation spectra in coloured KCl crystals. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 87-9 (Feb., 1961)].

17576 EXCITON-INDUCED F-CENTER GROWTH IN KI AND KBr CRYSTALS. J.H.Parker, Jr.
Phys. Rev. (USA), Vol. 124, No. 3, 703-12 (Nov. 1, 1961).
A study was made at room temperature of the growth in F-centre concentration resulting from the absorption of photons in the energy range of the first fundamental band (exciton band) of KI and KBr crystals. The growth in F-centre concentration was followed by measuring the fractional change in transmission at the maximum of the F-band by an a.c. method capable of detecting a change in F-centre concentration of 10^{11} cm^{-3}. The crystals used in the study of the dependence of F-centre production on irradiating wavelength and crystal history were grown both by the Kyropoulos method (seed-pulled) and the Bridgman method (crucible-grown). For seed-pulled KI crystals the F-centre growth showed a consistent behaviour for irradiation throughout the exciton band. The growth was found to be describable as a volume process for which the F-centre density as a function of the number of photons absorbed per unit volume is given by a saturating curve whose shape and initial slope (quantum efficiency) are approximately independent of irradiating wavelength but whose saturation level increases with decreasing wavelength. The F-centre saturation density was found to increase from 5×10^{15} cm^{-3} for irradiation in the tail of the band to about 5×10^{17} cm^{-3} at the peak of the band, with the initial quantum efficiency remaining between 0.1 to 0.2 for this wavelength range. While the behaviour for seed-pulled KI samples was relatively unaffected by either plastic deformation or previous irradiation in the exciton band, the crucible-grown samples showed large changes due to either of these treatments. Before these treatments the F-centre density induced in the crucible-grown samples had predominantly a square-root dependence on the number of absorbed photons; afterwards the behaviour was very much like that of the seed-pulled samples. The KBr crystals were found to behave like the seed-pulled KI samples. The results are discussed in

terms of the properties of the exciton and its interaction with negative-ion vacancies to form F-centres.

F_2^+-CENTRES IN ALKALI HALIDES. See Abstr. 14597

17577 COLOUR CENTRES IN X-IRRADIATED ALKALI METAL AZIDES. H.G.Heal and J.P.S.Pringle.
J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 261-9 (Oct., 1960).

Sodium, potassium, rubidium and caesium azides X-irradiated at liquid nitrogen temperature develop F-bands, other absorption bands at longer wavelength, ascribed to electron surplus centres, and V-bands in the ultraviolet. At room temperature, sodium azide gives a broad band in the ultraviolet ascribed to photoemission by sodium metal; potassium develops two bands in the red ascribed to R-centres. Caesium and rubidium azides develop broad structured bands in the ultraviolet of undetermined origin.

17578 PROPERTIES OF LITHIUM HYDRIDE. II. OPTICAL ABSORPTION BY COLOR CENTERS.
F.E.Pretzel and C.C.Rushing.
J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 232-45 (Jan., 1961).

For Pt I, see Abstr. 769 of 1961. The optical properties of colour centres involving trapped electrons in LiH show that properties of the crystalline media other than the lattice parameter are important in relation to the energy of the optical absorption bands. The F band in LiH is found at 2·4 eV instead of at 4·8 eV, as predicted by the Ivey formula for F bands in the alkali halides. Other properties of the F band in LiH are consistent with expectations from the F-centre model and with the high vibrational frequency and high cation-vacancy mobility in LiH crystals. The M band, Li-colloid band and other bands in LiH are also shifted to lower energy; therefore, the sequence of bands in LiH is comparable to the familiar sequence found in KCl. The principal V band in LiH is at 3·5 eV. The properties of the centre responsible for the V band are consistent with those of an H_2 molecule trapped at an anion site. This is the same as one proposed for the V_1 centre in KCl. "Impurity" bands are found both in "pure" and in Mg-doped LiH crystals. Bands due to Mg colloid and Z-type centres are found, along with a series of fine-structure lines like those previously reported only in LiF.

17579 SOLID STATE PHOTOCHEMICAL PROCESSES IN SODIUM AZIDE.
G.J.King, B.S.Miller, F.F.Carlson and R.C.McMillan.
J. chem. Phys. (USA), Vol. 35, No. 4, 1442-50 (Oct., 1961).

Some properties of vacancy colour centres produced by ultraviolet light in NaN_3 at low temperature are studied by optical absorption and ESPR techniques. Thermal and optical bleaching experiments are discussed which allow one to correlate the optical bands with the ESPR data. The experiments are interpreted in terms of the de Boer model of the F centre and the Seitz models of the F_2 and F_2^+ centres. Calculations based on the continuum models for these centres are made and are found to be in favourable agreement with the experimental data. A mechanism for the creation of vacancies and the subsequent formation of the colour centres based on photolytic effects is proposed.

SCATTERING OF POLARONS BY F-CENTRES.
See Abstr. 17478

17580 X-RAY INDUCED CONVERSION IN THE ABSORPTION BANDS OF ADDITIVELY COLOURED KCl.
G.Baldini, L.Dalla Croce and R.Fieschi.
Nuovo Cimento (Italy), Vol. 20, No. 4, 806-11 (May 16, 1961).

The additively coloured crystals of KCl were irradiated with F light to produce complex centres such as M, R and N. The crystals were then irradiated with X-rays and absorption coefficients in the bands due to these and F centres were measured. When the maximum absorption coefficients in these bands were plotted as a function of X-ray exposure time, the F band grew monotonically. The M band increased during the first stages of the irradiation, then decreased; the R band decreased rapidly and the N bands decreased slowly. The conversion of the complex centres into the F centres could be explained as being due to the radiationless recombination of electrons and holes or excitons; or due to trapping of holes by an electronic complex centre. Similar experiments with crystals containing Z centres show that the X-ray irradiation at liquid nitrogen temperatures has no effect on the Z bands but the irradiation at room temperature converts the Z bands into F bands. The rate for $Z_1 \rightarrow F$ conversion is lower than that the rate for $Z_2 \rightarrow F$ conversion. S.C.Jain

17581 OPTICAL ABSORPTION OF M CENTERS IN POTA UM CHLORIDE CRYSTALS. F.Okamoto.
Phys. Rev. (USA), Vol. 124, No. 4, 1090-7 (Nov. 15, 1961).

The absorption was studied by observing the anisotropy in in the crystals after bleaching with polarized light. It was foun that the M-centre has absorption bands hidden under the F-ban addition to an absorption in the 800 mμ region. The observed anisotropy near the F-band is the result of the presence of oth absorption bands in the F-band region. The optical absorption of R- and N-centres were also studied. The change in the loca and half-width of the F-band during bleaching can be accounted by the presence of secondary centres.

17582 N BANDS IN ALKALI HALIDE CRYSTALS. S.Hattori.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2117-18 (Nov., 1960).

Thermal enhancement of the N-bands is reported together the results of bleaching with M-light. J.E.C

17583 PRODUCTION OF V_3 CENTERS IN KCl BY X RAYS R.W.Christy and D.H.Phelps.
Phys. Rev. (USA), Vol. 124, No. 4, 1053-60 (Nov. 15, 1961).

The growth of the V_3-band was studied in X-ray irradiated KCl at room temperature, by measuring the optical absorption a function of X-ray dose. In the region in which the F-band gro linearly with time (after the initial "fast coloration"), the V_3-ba height increases approximately as the square root of the time. V_3-band growth rate varies with X-ray intensity and depth in th crystal in the same way as that of the F-band, however. Altho the F-band can be optically bleached without affecting the V_3-ba if the F-band is optically bleached during the X-ray irradiation V_3-band likewise fails to grow. These facts are thought to be consistent with a model of the V_3-centre in which a Cl_3^- molecu ion is located at a cation vacancy. The centre could be formed by the X-ray production of an anion vacancy—interstitial pair a the diffusion of a cation vacancy to the interstitial.

17584 ELECTRONIC PROCESSES AND Z CENTRES IN NaCl AND KCl CRYSTALS.
A.Bohun, J.Kantůrek, J.Trnka and M.Lébl.
Czech. J. Phys., Vol. 10, No. 5, 349-59 (1960).

Gives the experimental results of the study of coloured "p and Ca doped NaCl and KCl crystals. The mechanism of the fo ation of R centres by coagulation of F centres and of the forma of Z centres from F centres, cation vacancies and Ca ions is discussed. An alternative model for Z_3 centres is proposed. T possible connections between physical and chemical behaviour indicated.

17585 THE COLLOIDAL BAND IN KCl CONTAINING NaC S.Nakashima.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1650-1 (Aug., 1961).

Heating at 200°C and bleaching additively coloured NaCl-doped KCl crystals produced a band which is attributed to collo K–Na alloy. The atomic ratio of Na to K in the alloy is calcul ed. The position of the band moves to shorter wavelengths as NaCl concentration is increased. J.E.C

Radiation Effects

17586 RADIATION-INDUCED CHANGES IN SOME PHYSIC PROPERTIES OF GRAPHITES OF VARIOUS DEGR OF GRAPHITIZATION. Yu.N.Aleksenko and L.E.Kakushadze.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 131-2 (July, 1960).

Volume increase of graphite after neutron irradiation is assumed to result from decrease in size of the crystallites, i.e. to graphitization. Six samples of graphites of various degr of graphitization were irradiated by 6.2×10^{20} neutrons cm^{-2} a 350°-450°C. The absolute radiation-induced changes in electri and thermal resistivities are, within accuracy of the measurements, independent of graphitization. The relative changes are smaller for the less graphitized samples. Thermal conductivit versus temperature indicates that the radiation-induced breako of the crystal lattice in graphite has the same effect on the pro gation of thermal vibrations as the crystallite boundaries or impurities. The mechanism by which radiation affects the elec conductivity of graphite appears to be that of forming additiona

s for the current carriers. Radiation-induced changes in the coefficient were observed previously. Swelling was practic- absent in these experiments which suggests that this is due ss stable forms of radiation damage. H.E.Schmid

7587 ELECTRON MICROSCOPE STUDIES OF DAMAGE IN IRRADIATED URANIUM DIOXIDE.
.Newkirk, Jr, J.L.Daniel and B.Mastel.
clear Materials (Internat.), Vol. 2, No. 3, 269-73 (Sept., 1960).
rench.

7588 FOCUSING COLLISIONS IN A LINEAR CHAIN OF ATOMS. E.M.Baroody.
s. Rev. (USA), Vol. 124, No. 3, 745-7 (Nov. 1, 1961).
Focusing of the Silsbee type (Abstr. 8450 of 1958) is studied in w of identical atoms with the uniform spacing S, which interact ng collisions through a repulsive potential V (r). Two energy- ndent parameters are introduced: the distance of closest approach head-on collision c, and $\gamma = -(d \ln V / d \ln r)_{r=c}$. In terms of e, the focusing parameter $\Lambda = \theta_2/\theta_1$ is approximately $(SI_0/c) - 1$, re I_0 is an integral involving V(r) which depends mainly on γ. simple exponential potentials and large γ,

$$I_0 = 1 + (\ln 4)/\gamma - 1.368/\gamma^2 + 3.41/\gamma^3 \ldots .$$

eciably less focusing is predicted than follows from earlier oximations which correspond to putting $I_0 = 1$. For <110> chains pper, focusing is found at energies below 23 eV. This compares with the 30 eV obtained by Gibson et al. (Abstr. 20856 of 1960), heir three-dimensional model of copper.

7589 THE PRECIPITATION OF LEAD DURING DECOMPOSITION OF LEAD IODIDE BY ELECTRON IRRADIATION.
Forty.
Mag. (GB), Vol. 6, 895-905 (July, 1961).
Crystals of lead iodide decompose under electron irradiation metallic lead and iodine gas. This paper describes the observ- s which were made on the mode of decomposition, particularly e way in which precipitates of lead nucleate and grow inside the nt crystal. At low rates of decomposition the lead precipitates st uniformly in the form of very small (100-1000 A in diameter) riented crystallites. There is some slight tendency for depo- n to occur along dislocations. At high rates of decomposition ead precipitates in larger platelet form with a definite degree ientation between the precipitate and the lead iodide. These lets appear to nucleate and grow within cavities which are uced inside the parent crystal by the electron bombardment. bservations suggest an interesting mechanism for the growth spreading of decomposition throughout the crystal.

7590 ANGULAR DISTRIBUTION OF PARTICLES EJECTED ON THE IRRADIATION OF A MONOCRYSTAL BY AN BEAM. V.A.Molchanov, V.G.Tel'kovskii and V.M.Chicherov.
Akad. Nauk SSSR, Vol. 138, No. 4, 824-5 (June 1, 1961).
ıssian.
When an ion beam strikes a monocrystal, atoms are ejected rections characteristic of the crystal axes. Experiments here ribed aim to establish the distribution in space of those ejected s which pass right through the target. These are found to be entrated in $\pm 20^0$ cones about the directions of the crystal axes. lish translation in: Soviet Physics—Doklady (USA), Vol. 6, , 486-7 (Dec., 1961)]. A.E.I. Research Laboratory

7591 INFLUENCE OF TEMPERATURE AND BOMBARDMENT RATE ON DISORIENTATION OF SILVER SINGLE STALS BY ION BOMBARDMENT. G.J.Ogilvie and A.A.Thomson.
hys. Chem. Solids (GB), Vol. 17, No. 3-4, 203-9 (Jan., 1961).
Single crystals of silver with (110), (001) and (111) planes llel to the surface were bombarded by positive ions of argon ng an energy of 130 eV at constant temperatures in the range 400^0 C. Transmission electron diffraction patterns obtained n thinned regions in the crystals show that disoriented crystal- and stacking disorders are caused by the bombardment. The cts due to disoriented crystallites decrease in intensity as the perature of bombardment increases. It is shown that the rientation increases with increasing current density of ions the change in disorientation with annealing is studied. The ication of the results to the problem of producing clean surfaces n bombardment is discussed. It is shown that thermal annealing t sufficient to account for the change in disorientation with bardment temperature. The possibility is examined that point cts introduced by bombardment accelerate annealing.

17592 THE EFFECT ON FAST NEUTRONS ON CRYSTALLINE QUARTZ AND VITREOUS SILICA.
G.Mayer and M.Lecomte.
J. Phys. Radium (France), Vol. 21, No. 12, 846-52 (Dec., 1960).
In French.
A dose of 2×10^{20} fast neutrons cm^{-2} transforms crystalline quartz and vitreous silica into the same isotropic substance. Measurements on density, thermal expansion, internal energy, elastic and piezoelectric constants were used to follow this trans- formation. Before reaching the isotropic state the irradiated quartz crystals assume the symmetry characteristics of β-quartz. On reheating, and according to the neutron dose received, these crystals can be transformed either into vitreous silica, or again into natural quartz, or into another structure which is described.

17593 FORMATION OF LATTICE DEFECTS UNDER THE ACTION OF THERMAL NEUTRONS ON IRRADIATING SILICON SINGLE CRYSTALS IN A NUCLEAR REACTOR.
M.V.Chukichev and V.S.Vavilov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1522-7 (May, 1961).
In Russian.
For abstract, see Abstr. 14347 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1103-6 (May, 1961)].

EFFECT OF Co^{60} γ-RADIATION ON THE DIELECTRIC PROPERTIES OF TRIGLYCINE SULPHATE. See Abstr. 17832

17594 PARAMAGNETIC DEFECTS IN IRRADIATED NH_4ClO_4.
T.Cole.
J. chem. Phys. (USA), Vol. 35, No. 4, 1169-73 (Oct., 1961).
Analysis of the electron magnetic resonance of X-ray damaged crystals of NH_4ClO_4 showed that the long-lived defects were NH_3^+ ions. Isotropic hyperfine splittings were found to be 54.6 Mc/s for nitrogen and 72.5 Mc/s for hydrogen. These radicals appear to be planar and execute restricted rotation at room temperature. A second transient defect was identified as ClO_3.

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

17595 THE ANOMALOUS SKIN EFFECT.
G.E.Smith.
Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 182-96; Disc., 210-12.
Anomalies in the high-frequency resistance of metals at low temperatures were first noticed by H. London in 1940 and attributed to the mean free path, l, of conduction electrons being greater than the skin depth δ. This effect has become known as the anomalous skin effect, and the rise of microwave technology has fostered a fairly extensive study of the phenomenon. It has been shown that in the extreme anomalous limit, $l \gg \delta$, the surface resistance R be- comes independent of the relaxation time τ and is only a function of the size and shape of the Fermi surface. Because of this property, measurements of R have been used by several workers to obtain information on features of the Fermi surface. In the case of a suit- ably averaged R, such as in polycrystalline material, one obtains the total area of the Fermi surface, and measurements on single crystal material as a function of orientation yield information on its shape. Details of the effect are discussed and experimental results reviewed with emphasis on its advantages and limitations as a tool for invest- igating Fermi surfaces in metals.

17596 ANOMALOUS SKIN EFFECT IN ALUMINUM.
E.Fawcett.
Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 197-202; Disc., 210-12.
The anisotropy of the surface conductance Σ of aluminium under anomalous skin effect conditions was measured. The results are compared with a model of the Fermi surface similar to one propos- ed by Harrison (Abstr. 9887 of 1960), which is obtained from the free-electron sphere by shearing it normal to the lines of inter- section with the Brillouin zone faces so that in the third zone the

surface coincides with the slightly smaller sphere intersecting the zone corners. The average value of Σ^3 is used to estimate the ratio S/S_0 of the total areas of the Fermi surface to the area S_0 of the free-electron sphere. Measurements of Σ for polycrystalline samples of magnesium, zinc, and cadmium are also quoted in this form, and the values of S/S_0 are combined with specific heat data to obtain the Fermi velocities in these metals.

ELECTRICAL PROPERTIES OF ALKALI ANTIMONIDES. See Abstr. 15081

17597 AN EXPANSION THEOREM FOR THE ELECTRIC CONDUCTIVITY OF METALS. I. ELECTRIC CONDUCTIVITY FOR LONGITUDINAL ELECTRIC FIELD.
T.Izuyama.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 964-80 (June, 1961).

A systematic diagram representation in a composite 4-dimensional space is developed for Kubo's response function (Abstr. 8437 of 1957) which describes the electric response currents of metals for longitudinal electric fields. Proper diagrams are defined as the Feynman type linked diagrams which cannot be decomposed into simpler diagrams cinnected only by one Coulomb line. The greatest care is exercised with reference to the fact that Kubo's formula for the conduction phenomena gives the transport coefficient $\chi(q,\omega)$ defined as the ratio of the electric current vector to the electric displacement vector $D(q,\omega)$, while the electric conductivity $\sigma(q,\omega)$ of a metal is defined as the electric current vector divided by the electric field vector $E(q,\omega)$ in the metal. Thus $\sigma(q,\omega)$ is written as the product of $\chi(q,\omega)$ and the dielectric constant of the metal. It is shown that the product usrreduced to a simple form. In the reduced form, $\sigma(q,\omega)$ is expressed as the sum of the proper diagrams. In this expression the lowest order term in respect to the Coulomb interaction includes the usual sum on ring diagrams and, moreover, constitutes a much better approximation than the ring approximation.

17598 SPACE-TIME CORRELATION FUNCTION IN THE THEORY OF ELECTRICAL CONDUCTIVITY.
I.Mannari.
Progr. theor. Phys. (Japan), Vol. 26, No. 1, 51-83 (July, 1961).

A formula is given for the electrical resistivity of metals using the result of excitation-response theory. It is shown that the electrical resistivity is expressible in terms of the four-dimensional Fourier transform of the appropriate pair correlation function in space and time of the scattering systems, by which conduction electrons are scattered to lose their initial velocity. The dependence of the electrical conductivity on the effects of the correlation in the scattering system is discussed systematically by using the correlation functions in some of the typical examples. The electrical resistivity of the ferromagnetic metals in particular is discussed in some detail by using the so-called s–d interaction model. In this case it is shown that the inclusion of the effect of the correlation between d spins gives rise to deviations in electrical resistivity from the one given by the simple molecular field approximation.

17599 THEORY OF IMPURITY RESISTANCE IN METALS. II.
J.S.Langer.
Phys. Rev. (USA), Vol. 124, No. 4, 1003-10 (Nov. 15, 1961).

The many-body theory of impurity resistance which was developed in Pt I (Abstr. 17985 of 1960) is extended to include all corrections resulting from electron–electron interactions. The model used is a normal Fermi fluid in the presence of a small but finite concentration of randomly scattered, fixed impurities. The resulting expression for the conductivity may be interpreted in terms of independent single-electron-like excitations, or "quasi-particles". The combined effect of the impurities and the many-body interactions causes these quasi-particles to carry current at their group velocity, but there is no effective charge correction.

17600 ELECTRICAL RESISTIVITY OF METALLIC ALLOYS AS A FUNCTION OF ORDERING.
M.T.Beal.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 72-81 (Aug., 1960). In French.

Studies theoretically how the ordering of alloys and its influence on resistivity vary with temperature. A molecular-field approximation is used, with interactions between nearest neighbours only. A recurrence formula gives the ordering parameters of shells of neighbours at increasing distances from given atoms. The resistivity is then computed, taking into account nearest neighbours only, and with a model of free electrons scattered in the Born approximation. This study is quite general above the critical te erature T_c; only the simple case of β-brass is studied below T_c The short-range order is found to have very little effect, except the immediate neighbourhood of T_c. It contributes to the resist a term with a finite slope just below T_c, and with a non-vanishir slope just above T_c. These conclusions are in fairly reasonable agreement with observations made on Cu_3Au, Cu-Znα, Cu-Znβ Au_3Cu.

17601 THE TEMPERATURE DEPENDENCE OF THE RESISTIVITY OF FERROMAGNETIC METALS.
R.R.Birss and S.K.Dey.
Proc. Roy. Soc. A (GB), Vol. 263, 473-82 (Oct. 10, 1961).

The temperature dependence of the resistivity of nickel and gadolinium was measured. For nickel, the results are in good agreement with the band-structure calculations of Fletcher (Abstr. 3759 of 1952); for gadolinium the fractional change in resistivity is almost exactly equal to the fourth power of the reduced magnetization.

17602 THEORY OF THE RESISTANCE MINIMUM IN DILU PARAMAGNETIC ALLOYS.
A.D.Brailsford and A.W.Overhauser.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 140-5 (Aug., 1960

The observed anomalous temperature dependence of the re ivity of dilute paramagnetic alloys is attributed to s–d exchang scattering of conduction electrons by nearest neighbour pairs o ferromagnetically coupled solute ions. Occurrence of a resista minimum can be explained quantitatively only if the effective ra of the s–d exchange potential is not too short; and only if the periodic structure of energy bands is taken into account. The s of the minimum is proportional to the square of the solute conc tion in the limit of extreme dilution (< 1%). Deviations from thi law at higher concentrations are explained satisfactorily.

ELECTRICAL RESISTIVITY IN DEFORMED METALS. See Abstr. 17508

THEORY OF ELECTRICAL RESISTIVITY OF ALKALI ME See Abstr. 17439

RESISTIVITY OF Al–Pu ALLOY. See Abstr. 17412

17603 INFLUENCE OF OXYGEN CONTENT ON ELECTRI AND THERMOELECTRIC PROPERTIES OF TERN SYSTEM $Bi_2Ti_{3-x}Se_x$. K.Šmirous and L.Štourač.
Czech. J. Phys., Vol. 10, No. 9, 659-62 (1960). In Russian.

A study is made of the influence of oxygen, contained in the semiconducting system $Bi_2Ti_{3-x}Se_x$, on the electric and thermo electric properties. It is shown that the addition of oxygen to t prepared samples $Bi_2Te_{3.4}Se_{0.6}$ causes a decrease in electric conductivity while the thermoelectric force remains unchanged This influence is connected with a decrease in the mobility of t electrons but their concentration is not influenced by the prese of oxygen. Conclusions are reached as to the influence of oxyg on the efficiency of the conversion of thermal energy into elect energy and vice versa.

17604 INVESTIGATION OF THE ELECTRICAL RESISTAN OF CERIUM, LANTHANUM AND NEODYMIUM AT PRESSURES UP TO 250 000 kg/cm^2.
L.F.Vereshchagin, A.A.Semerchan and S.V.Popova.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 5, 1059-61 (June 11, 1961 In Russian.

For abstract, see Abstr. 14356 of 1961. [English translati in: Soviet Physics–Doklady (USA), Vol. 6, No. 6, 488-9 (Dec.,

17605 EFFECTS OF TRANSITION METAL SOLUTES ON T ELECTRICAL RESISTIVITY OF COPPER AND GO BETWEEN 4° AND 1200°K.
C.A.Domenicali and E.L.Christen
J. appl. Phys. (USA), Vol. 32, No. 11, 2450-6 (Nov., 1961).

The solute contribution $\rho_i(T,c)$ was determined for the solute Cr, Mn, Fe, Co, and Ni in copper and of the solutes Mn, Fe, and Co i over the temperature range 4° to 1200°K and over a wide range of s concentrations. The parameter $\rho_i(T,c)$ for a given solute is defined here as the difference $\rho_{alloy}(T,c) - \rho_{solvent}(T)$. The temperature dependence of ρ_i is quite complicated for several the solutes in particular Fe and Co. For example, in an alloy containing 0.05 at.% Fe in copper the quantity ρ_{Fe} exhibits a

mum at 25°K and a maximum at 65°K. Alloys of Fe in gold
oit a broad maximum in ρ_{Fe} at temperatures between 70° and
K, depending upon the iron concentration. In all the alloys
stigated, except for Ni in copper, ρ_i decreases with increasing
erature in the region of high temperatures (above about 500°K).

7606 ELECTRICAL RESISTANCE OF COPPER–GOLD ALLOYS AT LOW TEMPERATURES.
rabayashi and Y.Muto.
metallurgica (Internat.), Vol. 9, No. 5, 497-503 (May, 1961).
Electrical resistance of the copper–gold alloys containing
24.1, 25.0$_v$, 50.8, 74.0 and 75.0$_e$ at.% gold was measured in the
e from liquid helium to room temperature in the annealed and
ched states. It was established that the residual resistance of
5.0$_e$% alloy is lower in the ordered state than in the disordered
and that the ratios of the residual resistance to the ice point
tance are 0.699 and 0.800 for the ordered and disordered
s, respectively. Also it was found for the 74.0% alloy that the
ual resistance of the partly ordered state is higher than that of
isordered state. The Debye temperatures of the alloys were
ated by using the Grüneisen formula. 185° and 160°K were
ned for the 75.0$_e$% alloy in the ordered and disordered states,
ectively. A resistance minimum of the magnitude of 0.01 $\mu\Omega$-cm
found in the neighbourhood of 13°K for the 25.0$_v$% alloy. Such
imum seems to be little affected by the degree of order, and
hought to be due to the presence of small amounts of certain
rities. This view was supported by an appearance of more
ct minimum near 19°K for the 23.5$_v$% alloy containing 0.16%
as an impurity.

7607 SOME ELECTRICAL RESISTIVITY MEASUREMENTS ON A SERIES OF IRON–CHROMIUM ALLOYS.
Powell, R.P.Tye and M.J.Woodman.
Mag. (GB), Vol. 6, 857-62 (July, 1961).
Results are presented for the electrical resistivities of iron and
iron–chromium alloys of up to 5.58% chromium content, at
eratures ranging from that of liquid helium to above the alpha–
ma transformation of each sample. Both the temperature of
formation and the consequent decrease in apparent electrical
tivity (neglecting dimensional changes) are approximately
r functions of the chromium content. For the series studied
ransformation temperature decreases from about 910°C to
C, whilst the decrease in resistance increases from about
o 2.2%. Hysteresis is observed on cooling.

7608 THE ELECTRICAL RESISTIVITY OF LITHIUM-6.
J.S.Dugdale, D.Gugan and K.Okumura.
. Roy. Soc. A (GB), Vol. 263, 407-19 (Sept. 19, 1961).
The electrical resistivities of Li^6 and lithium of natural isotopic
osition were studied between 4°K and room temperature. In
ion, their absolute resistivities were carefully compared at
temperature. These measurements show that the effect of
mass on electrical resistivity agrees with simple theoretical
ctions namely, that the properties of the conduction electrons
hium do not depend on the mass of the ions, and that the
acteristic lattice frequencies for the two pure isotopes are in
verse ratio of the square roots of their ionic masses. A
arison with the specific heat results of Martin (Abstr. 7852,
3 of 1960), where the simple theory is found not to hold, indicates
ossibility that anharmonic effects are present which affect the
fic heat but not the electrical resistivity.

EFFECT OF SHORT-RANGE ORDER ON THE RESIDUAL STANCE OF NICKEL ALLOYS. See Abstr. 15128

7609 THE ELECTRICAL AND MAGNETIC PROPERTIES OF THE URANIUM–NIOBIUM SYSTEM.
Bates and R.D.Barnard.
. Phys. Soc. (GB), Vol. 78, Pt 3, 361-9 (Sept., 1961).
The magnetic susceptibilities and electrical resistivities of a
es of γ-phase U–Nb alloys were measured over the temperature
es 293-1200°K and 90-1200°K, respectively. The form of the
tivity–temperature–concentration relations is abnormal,
cially at low temperatures, where negative temperature
icients of resistivity occur in the uranium-rich alloys, and no
nation can be found in terms of localized moments on either
Nb atoms. Comparison is made of the same properties of the
-Mo alloys and particular attention is directed towards the electronic band structure of niobium. A rigid band model is shown to be appropriate for dilute solid solutions of uranium and molybdenum, but such a model is not applicable to the uranium-rich γ U–Mo and U–Nb alloys.

EFFECT OF Ga FILM ON ELECTRICAL CONDUCTIVITY OF Zn, Cd AND Sn. See Abstr. 14910

17610 ELECTRICAL RESISTIVITY OF THIN FILMS OF GALLIUM OF THICKNESS GREATER THAN 30 mμ.
S.Martinuzzi.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3244-6 (May 24, 1961).
In French.
The results obtained in the study of the electrical resistivity of thin films of gallium at 293°K and 100°K are reviewed and compared. A.J.Fox

17611 A CONTRIBUTION TO THE STUDY OF THE INFLUENCE OF THE ADSORPTION OF GAS ON THE ELECTRICAL CONDUCTIVITY OF VERY THIN METALLIC FILMS. S.Offret.
J. Rech. Cent. Nat. Rech. Sci.(France), No. 55, 97-127 (June, 1961).
In French.
Details are presented of the adsorption of light gases (H_2, O_2, N_2 and He) on platinium and other metallic films, of less than 100 A thickness, which were produced by thermal evaporation under vacuum. Modern ultra-high vacuum practice was followed and experiments were conducted over the pressure range from 10^{-4} torr to 10^{-10} torr with a temperature range from 20°K to 393°K. The nature of the adsorption, physical (molecular) or chemical (probably atomic), is evidenced by variation of the electrical conductivity of the film and results are fully discussed. Correlation is obtained with published contact potential data. F.A.Baker

17612 DISTURBANCES CAUSED BY MERCURY IN THE STUDY OF THE ADSORPTION OF GAS BY VERY THIN FILMS OF PLATINUM.
Sen Sik Minn, S.Offret and B.Vodar.
C.R. Acad. Sci. (France), Vol. 252, No. 22, 3445-7 (May 29, 1961).
In French.
A study of the variation of the electrical resistivity due to adsorption of hydrogen was carried out under very high vacuum conditions and also under high vacuum using a mercury pump. In the first case the resistivity increased and then decreased in a reproducible manner but when the system was subject to Hg vapour the results were difficult to reproduce. There was evidence of an anomalous adsorption of Hg leading to a lowering of the resistivity. T.C.Toye

17613 ADSORPTION OF GAS AND THE ELECTRICAL CONDUCTIVITY OF VERY THIN FILMS OF PLATINUM.
Sen-Sik Minn, S.Offret and B.Vodar.
C.R. Acad. Sci. (France), Vol. 253, No. 3, 442-4 (July 17, 1961).
In French.
The films were prepared by evaporation in an ultra high vacuum system at 10^{-10} torr with an initial surface resistance of 2×10^7 ohm corresponding to a thickness of about 15 A. They were subsequently subjected to pure gases of H_2, O_2, N_2 and He at a constant pressure of 5×10^{-4} torr while changes in electrical resistance were observed for films at both 293°K and at 77.4°K. It was found that helium had no effect on the resistance; oxygen first caused a small increase followed by a considerable decrease in resistance at both temperatures; hydrogen showed a small increase at 293°K while it behaved like oxygen at 77.4°K, and nitrogen only showed an increase in resistance at both temperatures. These observations were explained in terms of ionization potentials and electron affinities for these gases from which it was suggested that: hydrogen was first always adsorbed in the atomic state but at 77.4°K in the molecular state; oxygen was first adsorbed in the atomic and then in the molecular state at both temperatures; whereas nitrogen was only adsorbed in the atomic state and helium was not taken up at all. W.Steckelmacher

17614 CAUSES OF THE ANOMALOUS VARIATIONS OF ELECTRIC RESISTANCE AS A FUNCTION OF TEMPERATURE IN SILVER FILMS DEPOSITED AT LOW TEMPERATURES. A.Dévényi.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 4, 807-15 (1959).
In Roumanian.
The causes of anomalies appearing when the electric resistance varies as a function of temperature in silver films deposited at

-130° C are studied. It is shown that the main cause for this anomalous behaviour is the presence of breaks in the film, which deviate the R(T) curve from its normal course and determine the appearance of secondary minima before reaching the lowest value of the electric resistance. The way in which the real value of the silver film thickness can be obtained from the minimum of the electric resistance by applying a correction factor computed from the R(T) curve, is shown. From the investigations, it appears that the principal cause of breaks is contraction and not the presence of gases included in the film during its formation. The tensions in the film reach a critical value at about -50° – -20° C (critical breaking temperature). In complying with all working conditions indicated in the paper, silver films without any anomalous behaviour of the R(T) curve can be obtained in most experimental cases.

17615 MAGNETORESISTANCE.
R.G.Chambers.
Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 100-24; Disc., 141-4.

After a brief review of the properties of spherical, ellipsoidal and cylindrical energy surfaces, the general magnetoresistance problem is discussed for the low-field, intermediate-field and high-field regions in turn. The Jones–Zener solution for low fields can give some information about the Fermi surface, but only if some assumption is made about the anisotropy of relaxation time. At intermediate fields, where the transport equation cannot be solved by series expansion in either $\omega\tau$ or $(\omega\tau)^{-1}$, the variational method is particularly useful, and with this approach it may also be possible to separate out Fermi surface anisotropy from relaxation time anisotropy. At high fields, as Lifshits and Peschanskii have shown, the magnetoresistance behaviour is largely determined by the presence or absence of open electron orbits, and a discussion is given of Fermi surface topologies and types of electron orbit. The theory of high-field behaviour is then outlined, and the results of Alekseevskii and Gaidukov discussed. The paper concludes with a brief survey of recent work on the theory of oscillatory magnetoresistance in the quantum region.

MAGNETORESISTANCE OF P-TYPE SEMICONDUCTING DIAMOND. See Abstr. 17728

17616 THE LONGITUDINAL MANGETORESISTANCE OF SEMICONDUCTORS OF THE N-GERMANIUM TYPE IN THE QUANTUM LIMIT. M.N.Ryabinin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1310-13 (May, 1961). In Russian.

For abstract, see Abstr. 12416 of 1961. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 947-9 (Nov., 1961)].

17617 A NOTE ON THE MAGNETORESISTANCE OF PbTe AT HIGH MAGNETIC FIELDS. E.Yamada and K.Shogenji.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1475 (July, 1961).

The periods of oscillation in the magnetoresistance of PbTe at high magnetic fields are calculated from the conductivity tensor. Oscillations of the Hall coefficient are attributed to higher-order terms of H^{-1} which are neglected in the magnetoresistance calculation. P.E.Seiden

OSCILLATORY MAGNETORESISTANCE IN THE CONDUCTION BAND OF PbTe. See Abstr. 17748

17618 ANISOTROPY OF GALVANOMAGNETIC TENSORS OF SEMIMETALS WITH PARTICULAR ATTENTION TO BISMUTH. S.Mase.
Fermi Surface Conference Paper, Cooperstown, New York, Aug., 1960 (see Abstr. 11180 of 1961) p. 134-40; Disc., 141-4.

A theory of the galvanomagnetic effect in semimetals with several ellipsoidal bands is presented. Attention is directed to an analysis of the relation between the energy bands and the anisotropy of the galvanomagnetic tensor of bismuth crystals which show extreme anomalies in various physical properties. The applicability of the theory is limited to the range of low energy phonon scattering which is pre-dominant, i.e. to moderately low temperatures, from experimental and theoretical points of view. With the assumptions of a classical distribution and the Debye approximation for phonons, nearly isotropic scattering is obtained below the quantum limit, irrespective of any anisotropy of the energy bands. If the fundamental assumption of the effective-mass approxima is valid, one can determine the shapes of the Fermi surfaces o semimetals by comparing the theoretical expression for the anisotropic galvanomagnetic tensor for arbitrary direction of magnetic field with experiments. Because of scanty data from satisfactory experiments, the author gives only the predicted curves of the galvanomagnetic tensor of bismuth versus the magnetic field, using the effective masses from cyclotron-abso experiments instead of determining the energy band shape.

17619 THE EFFECT OF PRESSURE ON THE ELECTRIC RESISTANCE AND GALVANOMAGNETIC EFFECT CHROMIUM TELLURIDE.
N.P.Grazhdankina, L.G.Gaidukov, K.P.Rodionov, M.I.Oleinik an V.A.Shchipanov.
Zh. eksper. teor. Fiz. (USSR), Vol. 40, No. 2, 433-40 (Feb., 19 In Russian.

The temperature dependences of the electrical resistivity of the galvanomagnetic effect were measured in chromium tell near the magnetic transition temperature at a pressure of 4 600 kg/cm^2. The shift in the Curie point under hydrostatic compression of the specimen was determined. The variation i the exchange integral with interatomic distance in the Cr–Te system was also studied by measuring the electrical, magnetic and galvanomagnetic properties of solid solutions of Cr–Te–S On the basis of the data obtained, it is deduced from the therm dynamics of ferromagnetism that the nature of the change in spontaneous magnetization of CrTe is significantly different, depending on whether the reduction in the unit cell volume is produced by the hydrostatic pressure or by the introduction of selenium impurity. [English translation in: Soviet Physics–J (USA), Vol. 13, No. 2, 297-302 (Aug., 1961)].

17620 EXPERIMENTAL DETERMINATION OF THE GALVANOMAGNETIC CONSTANT OF COPPER SINGLE CRYSTALS. H.Bross and T.Ricker.
Z. Phys. (Germany), Vol. 163, No. 4, 489-98 (1961). In Germa

The galvanomagnetic constant of a single crystal of copper measured for various crystal orientations and at various temp tures, namely the boiling points of nitrogen and oxygen and at r temperature. A

17621 GALVANOMAGNETIC PROPERTIES OF InSb.
H.Weiss.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2064-8 (Oct., 19

"Semiconducting Compounds" Conference Paper, Schenect 1961 (see Abstr. 14428 of 1961). In discussing the galvanomag effects of semiconductors with high electron mobility one has t distinguish four main groups of parameters which influence the effects: (1) For InSb with practically no magnetoresistive effe a long rod, an increase in resistance by a factor 38 can be rea in 10 000 G with appropriate shape (field disk). (2) Layers per ically changing their electron concentration produce an anisotr of magnetoresistance. For certain specimen orientations, the coefficient depends on the magnetic field and a planar Hall effe observed. Near a step of concentration one measures apparent negative resistances which are caused not by a retrograde curr but merely by rotation of the current lines. (3) If there are mo than one type of charge carriers, it is difficult to know the con tration and mobility characteristic of a special type. Because the high mobility ratio in InSb, it is possible to state a hole mo of 620 cm^{2}V^{-1}sec^{-1} in 150 000, G for pure material at room tem ature. (4) After elimination of the influences of the above ment points 1 to 3, one cannot find in InSb any magnetoresistive effe electrons in the conduction band up to 150 000 G. The Hall coe ient is independent of the magnetic field up to this value of the magnetic induction for n-type InSb.

17622 GALVANOMAGNETIC PHENOMENA IN THE FER MAGNETIC MnSb ALLOY.
I.K.Kikoin, N.A.Babushkina and T.N.Igosheva.
Fiz. Metallov i Metetallovedenie (USSR), Vol. 10, No. 3, 488-9 (Sept., 1960). In Russian.

The effect of temperature on the Hall coefficient, electrica resistivity, and magnetization curves of MnSb was studied, and formula $R_J = \alpha - \beta\,\Delta\rho$ was derived, where R_J is the ferromag Hall coefficient, $\Delta\rho$ is the decrease in resistivity of the specim due to the action of spontaneous magnetization, and α and β a constants. Apart from being more general, this formula has a

ler physical meaning than that due to Karplus and Luttinger .. 10366 of 1954). M.H.Sloboda

MAGNETOELECTRIC AND ELECTRONIC PROPERTIES OF OLYTIC CARBONS. See Abstr. 17525

623 THE EFFECT OF ANNEALING ON THE ANISOTROPY OF GALVANOMAGNETIC PROPERTIES OF TELLURIUM.
Parfen'ev, A.M.Pogarskii, I.I.Farbshtein and S.S.Shalyt.
tverdogo Tela (USSR), Vol. 3, No. 8, 2501-4 (Aug., 1961).
ssian. English translation in: Soviet Physics—Solid State).

7624 THE HALL EFFECT IN MONOVALENT METALS AT LOW TEMPERATURES. S.Simons.
. Phys. Soc. (GB), Vol. 78, Pt 2, 316-17 (Aug., 1961).
A variational method is used to obtain the change in the rical resistance tensor brought about by an applied magnetic at low temperatures, assuming that both electron scattering honon scattering are dominated by electron—phonon N process- This condition restricts the argument to those monovalent ls whose Fermi surfaces do not touch the first Brillouin zone dary. The expression obtained for the Hall coefficient is the e as that given by the elementary theory. J.F.Cornwell

7625 PRESSURE DEPENDENCE OF THE HALL CONSTANT OF THE ALKALI METALS.
eutsch, W.Paul and H.Brooks.
. Rev. (USA), Vol. 124, No. 3, 753-63 (Nov. 1, 1961).
The pressure dependence of the Hall constant of the five alkali ls was measured to 15 000 kg/cm^2 at room temperature. The ose of the measurements was to investigate the effect of lattice tant on the warping of the Fermi surface. The Hall constant written as 1/Necn*, where N is the number of carriers/cm^3 n* expresses the deviation from the free electron value of the constant. In all the alkalis except caesium, n* decreases otonically with increasing pressure; the decreases range from in 15 000 kg/cm^2 for lithium to 8% in 15 000 kg/cm^2 for dium. In the case of caesium, n* passes through a minimum 00 kg/cm^2 and rises to a value of 1.2 at 15 000 kg/cm^2. The ge of n* between room and liquid nitrogen temperatures was sured and is less than 3% for all the alkalis except lithium. thium, n* decreases about 25% between room and liquid nitrogen erature. The sign of the pressure dependence of n*, as well s magnitude, can be reconciled with band structure calculations am (1960) only if highly anisotropic scattering times are con- red. The pressure results are explained in a semiquantitative ner using a scattering time, τ, that varies by a factor of 3 over Fermi surface. Consideration of the factors determining the tering time indicates the both umklapp processes and the large tic anisotropy of the alkalis contribute to the anisotropy of τ. ude calculation shows that the present results can be explained ne effects of umklapp processes alone.

7626 HALL EFFECT IN THIN FILMS OF COBALT.
A.Colombani and H.Daridon.
Acad. Sci. (France), Vol. 253, No. 3, 411-13 (July 17, 1961).
rench.
The Hall effect of annealed films of cobalt was measured as a ion of magnetic field and film thickness at temperatures of up 0°C. M.A.Taylor

7627 THE HALL EFFECT IN MONOCRYSTALLINE MANGANESE FERRITES. K.P.Belov and E.P.Svirina.
tverdogo Tela (USSR), Vol. 3, No. 8, 2495-7 (Aug., 1961).
ssian.

7628 ORIGINS OF THE NERNST EFFECT IN FERROMAGNETIC METALS. E.I.Kondorskii.
eksper. teor. Fiz. (USSR), Vol. 40, No. 1, 381-2 (Jan., 1961).
ussian.
A relativistic effect, connected with the movement of current iers possessing a non-vanishing mean magnetism, is considered. effect is important in the theoretical description of the st effect in ferromagnetic metals. It is shown that from the sign ne Nernst field, one can determine how the magnetization of the rent carriers is directed with respect to the resultant spontaneous magnetization in the metal. [English translation in: Soviet Physics—JETP (USA), Vol. 13, No. 1, 260-1 (July, 1961)]. S.A.Ahern

17629 NERNST—ETTINGSHAUSEN EFFECT IN n-InSb.
D.Kh.Amirkhanova and R.I.Bashirov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 819-21 (March, 1961).
In Russian.
The dependence of the Nernst—Ettingshausen effect on the strength of the magnetic field was investigated in n-InSb at 30 and 117°K and fields up to 26 kOe. Influence of the quantization of the energy spectrum of the current carriers was found for $\hbar\omega_0 > 3kT$. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 598-9 (Sept., 1961)]. D.J.Huntley

17630 RIGHI—LEDUC EFFECT IN MERCURIC SELENIDE.
C.R.Whitsett.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2257-60 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). A preliminary study was made of the Righi—Leduc effect in mercuric selenide (HgSe). The Righi—Leduc magnetothermal effect is the thermal analogue of the Hall effect wherein temperature plays the role of voltage and heat flow replaces electric current. The effect is particularly large in HgSe because of the coincidence of large electron mobilities (as high as 1.5 m^2 V^{-1} sec^{-1} at 300°K) and low lattice thermal conductivity (about 0.02 w deg^{-1} K cm^{-1} at 300°K). Results are presented of measurements of the Righi—Leduc coefficient S as a function of temperature, magnetic field strength, and electron concentration. Classically, for a one-carrier material, $S \cong (\kappa_E/\kappa)\mu$, where κ_E is the electronic, κ is the total thermal conductivity, and μ is the electron mobility. This expression is in qualitative accord with the experimental results. At room temperature S ranged between 0.27 and 0.34 m^2 V^{-1} sec^{-1} for samples that had between 55×10^{17} and 5.6×10^{17} electrons cm^{-3}.

MAGNETOTHERMAL OSCILLATIONS AND THE FERMI SURFACE. See Abstr. 17457

17631 ELECTRICAL CONDUCTIVITY AND PHOTOCONDUCTIVITY OF THIN ANTHRACENE LAYERS IN VACUUM.
C.Gheorghiță-Oancea.
Brit. J. appl. Phys., Vol. 12, No. 10, 579-80 (Oct., 1961).
In order to eliminate as much as possible the surface phenomena produced by air and water vapour absorption, cells were prepared inside the vacuum system used for both the electrical conductivity and the photoconductivity measurements. It was observed that the dark and photocurrents increase with increase of pressure.

17632 THE TEMPERATURE DEPENDENCE OF THE CONDUCTIVITY OF DRY CELLULOSE. E.J.Murphy.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 66-71 (Aug., 1960).
An experimental investigation of the electrical conductivity is described. It leads to the following expression for the conductivity:

$$\sigma = 4{\cdot}50 \times 10^2 \exp(-30{\cdot}7 \times 10^3)/RT + 3{\cdot}55 \times 10^{-10} \exp(-10{\cdot}6 \times 10^3)/RT$$

where σ is the conductivity in $(\Omega\ \mathrm{cm})^{-1}$, R the gas constant, and T the absolute temperature. This has the form usual in the theory of ionic conduction in crystals. From the coefficient of the first term, the lattice constant for conduction can be calculated: the value obtained is 5·4 A. The observed energy in the Boltzmann factor for the first term can be regarded as splitting into the sum of two terms: a dissociation energy of 40·2 kcal/mole and an activation energy for mobility of 10·6 kcal/mole; this gives (40·2/2) + 10·6 = 30·7, the observed value. The second term, which is due to impurity conduction of some kind, has an activation energy for mobility of 10·6 kcal/mole. This agrees approximately with the activation energy for conduction in ice; consequently the second term is regarded as due to conduction in adsorbed water. The first term is regarded as representing volume conduction in which dissociation requires 40·2 kcal/mole, but mobility is governed by the breaking of two hydrogen bonds. The ratio $3{\cdot}55 \times 10^{-10}/4{\cdot}50 \times 10^2$ (= $0{\cdot}79 \times 10^{-12}$) is proportional to the concentration of "impurities". It is unusually small. A possible significance of this is discussed.

17633 INVESTIGATION OF THE ELECTRICAL CONTACT PROPERTIES OF GRANULAR CARBON AGGREGATES.
E.D.Macklen.
Brit. J. appl. Phys., Vol. 12, No. 9, 443-6 (Sept., 1961).

The heat treatment of granular carbon aggregates in various ambient gases was studied. In inert gases (hydrogen, nitrogen, argon, etc) and in vacuo, either a constant or a decreasing electrical resistance was observed for increasing heat-treatment temperature. Ambient gases containing either free or combined oxygen produced a sharp resistance maximum at about 530° C. The increase in resistance is attributed to the formation of a non-conducting surface oxide layer which decomposes on increasing the heat-treatment temperature.

17634 RADIATION EFFECTS ON THE ELECTRICAL PROPERTIES OF LITHIUM FLUORIDE.
P.Bergé and G.Blanc.
Bull. Soc. Franc. Mineral.Crist., Vol. 83, No. 10-12, 257-64 (Oct.-Dec., 1960). In French.

The electrical conductivity decreases on irradiating the crystals by γ rays and, qualitatively, the effect is independent of the dose. In the log σ versus 1/T plot, the curve starts with a very small value of σ at lower temperatures, increases progressively with temperature and joins the plot for the non-irradiated crystal at about 400° C. On irradiating the crystal with thermal neutrons, the conductivity first decreases as the flux of neutrons is increased and attains a minimum value at a flux of about 10^{15} nvt. On further increasing the flux of neutrons, σ starts increasing and ultimately attains values more than that for the non-irradiated crystal. The log σ versus 1/T plots for neutron irradiated crystals show a constant slope below 205° C. Above 250° C, the slope decreases progressively and attains a very small value near 350° C. Beyond this point σ decreases,attaining a minimum value near 400° C and later joins the characteristic log σ versus 1/T plot for a non-irradiated crystal. The results indicate two domains of temperature for these crystals irradiated with neutrons, in the first, at lower temperatures, σ decreases whereas in the second, at higher temperatures, it increases to attain its normal value. This conclusion is confirmed by the results of isothermal annealing at different constant temperatures. The conductivity is found to decrease with time at 328° C and to increase at 486° C. S.C.Jain

17635 ON THE ELECTRICAL CONDUCTIVITY OF Mn–Zn FERRITES. K.Závěta.
Czech. J. Phys., Vol. 11, No. 5, 376 (1961).

The electrical resistivity of a number of iron-deficient mixed manganese–zinc ferrites was measured in a temperature range which includes the Curie point. In some cases a linear log ρ–(1/T) relationship was found throughout the whole temperature range. In others a very slight anomaly is claimed at the Curie point [this is not convincingly demonstrated by the three graphs which are presented]. R.Parker

HEAT CAPACITY AND RESISTIVITY ANOMALIES IN PALLADIUM HYDRIDE. See Abstr. 17418

17636 THE CONDUCTIVITY OF POLYTHENE UNDER GAMMA IRRADIATION. H.J.Wintle.
Internat. J. appl. Radiation and Isotopes (GB), Vol. 8, No. 2-3, 132-4 (July, 1960).

The increase in electrical conductivity of polythene per unit of gamma irradiation at 0.014 rad/min is comparable to the increases obtained by others at much higher dose rates. However, in contrast to previous works, the rise and decay times were of the same order. J.A.Bornmann

17637 CHARACTERISTIC FEATURES OF THE CHANGE IN ELECTRICAL CONDUCTIVITY OF RUTILE CERAMICS IN THE PROCESS OF ELECTRICAL AGEING AND REGENERATION.
V.Ya.Kunin and A.N.Tsikin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 217-23 (Jan., 1961). In Russian.

Ageing is the process occurring in rutile ceramics at high temperatures and voltages, accompanied by an increase in the current and ultimately by the breakdown of the material. Ageing does not occur with alternating current nor with direct current if the polarity is periodically reversed, and under these conditions a regeneration process takes place. The ageing and regeneration processes are investigated experimentally and possible mechanisms based on the existence of defects in the rutile lattice are discu [English translation in: Soviet Physics–Solid State (USA), Vol No. 1, 158-63 (July, 1961)]. R.F.S.H

17638 CALCULATION OF THE CHANGE OF DEFECT CO CENTRATION IN RUTILE CERAMICS ON AGEING AND REGENERATION. S.N.Koikov, V.Ya.Kunin and A.N.Tsik Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 651-7 (Feb., 1961). In Russian.

On the basis of a one-dimensional model of potential barri the change in defect concentration in the presence of an electri field and at high temperature is calculated. The results agree experimental data for the change in current on ageing and rege tion (see preceding abstract). [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2, 477-81 (Aug., 1961)]. R.F.S.He

17639 POLARIZATION EFFECTS IN ELECTRICAL "CONDUCTIVITY" OF ARTIFICIAL SAPPHIRE AT HIGH TEMPERATURES. J.Cohen.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 285-90 (Nov., 19

The apparent electrical conductivity of artificial sapphire measured in vacuo in the temperature range 900-1300° C; the potential probe method was used to eliminate effects of high co resistance. Ohm's law was not applicable, and the apparent conductivity was nonuniform. Polarization effects were promi e.g., large polarization voltages, anomalous potential distribut and decays in current immediately after application of a voltag is suggested that these effects are due to electronic and ionic s charges resulting principally from impurities.

ELECTRICAL CONDUCTIVITY OF TiN. See Abstr. 14870

17640 SOME PROPERTIES OF TITANIUM SESQUIOXIDE CONTAINING VANADIUM IONS.
T.Kawakubo, T.Yanagi and S.Nomura.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2102 (Nov., 1960).

Measurements are reported of the lattice parameters and electrical conductivity of solid solutions containing up to 10 molar V_2O_3 in Ti_2O_3. The anomalous behaviour observed in pure Ti_2O_3 180° C is not found in these solid solutions.

17641 ELECTRICAL PROPERTIES OF NONSTOICHIOMETRIC URANIUM DIOXIDE.
S.Aronson, J.E.Rulli and B.E.Schaner.
J. chem. Phys. (USA), Vol. 35, No. 4, 1382-8 (Oct., 1961).

Electrical conductivity and thermoelectric power measure were made on nonstoichiometric UO_2 at temperatures of 500°-1 The conductivity data in the single phase UO_{2+X} region can be represented by the equation

$$\sigma(\text{ohm cm})^{-1} = (3.8 \times 10^6)/T(2x)(1-2x)\exp[(-0.30 \pm 0.03\ \text{eV})/k$$

An approximate equation for the thermoelectric power Q, is

$$Q = k/e \ln(1 - 2x/2x).$$

The electrical measurements confirm the ionic theory of non-stoichiometry in UO_2, postulated on the basis of thermodynamic evidence. Nonstoichiometric UO_2 is a relatively simple ionic s in which activated electronic hole transfer occurs between U^{5+} U^{4+} ions in the lattice.

17642 THERMOSTIMULATED E.M.F. APPEARING IN IRRADIATED HYDROCARBONS UNDER A TEMPE TURE GRADIENT. E.L.Frankevich and V.L.Tal'roze.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 180-1 (Jan., 1961). In Russian.

Paraffin and polyethylene were irradiated with 1.6 MeV el trons at 200°K and allowed to warm up. The e.m.f. was measu for temperature drops across the specimens of less than 20 de "Bursts" of e.m.f. appear between 250 and 280°K for paraffin a 260-280 and 340-380°K for polyethylene. The maximum voltag were 50-1000 V. There must be current carriers in shallow tr which may be radicals produced by the irradiation. The depen of the e.m.f. on the temperature gradient is probably due to the uniformity of trapped carriers rather than the gradient of carr concentration produced by the temperature gradient. The equiv electrical circuit is discussed. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 131-2 (July, 1961)]. R.Be

niconductors

643 SEMICONDUCTOR ABSTRACTS. Vol. VI - 1958 ISSUE. Edited by J.J.Bulloff and C.S.Peet.
York: John Wiley (1961) 528 pp.
Compiled by the staff of the Battelle Memorial Institute, nbus, Ohio. The contents consist of 1933 abstracts, some of reprinted from other journals, arranged in a classification ne based on the names of materials, with additional sections eory and on applications. Author and subject indexes are pro-

644 VOLUME-GRADIENT PHENOMENA AND THE LIMITS OF APPLICABILITY OF THE PROBE COMPENSATION HOD FOR MEASURING THE ELECTRICAL CONDUCTIVITY OF CONDUCTORS. P.I.Baranskii.
verdogo Tela (USSR), Vol. 3, No. 3, 884-8 (March, 1961).
ssian.
The effects considered are: (1) volume Peltier effect; (2) non-rm Joule heating and (3) volume-gradient Thomson effect, in a cally deformed n-type germanium specimen with a known tion of resistivity along its length. The voltage—current cteristic was found to be nonlinear in agreement with calcula- the departure being cubic in the current. As an example, it is d that to measure the resistivity of a single crystal of Ge with 0-20 ohm cm within 1%, $\nabla\rho$ must not exceed 0.5-1 ohm and the nt density must not exceed 10-15 mA/cm^2. [English transla-n: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 643-6 , 1961)]. R.Berman

645 MAGNETOELECTRIC AND THERMO MAGNETOELECTRIC EFFECTS IN SEMICONDUCTORS. II.
lefroy and J.Tavernier.
ys. Radium (France), Vol. 21, No. 6, 544-50 (June, 1960).
ench.
The results of Pt I (Abstr. 8932 of 1961) are used to calculate onductivity and thermoelectric power tensors in the general of a crystal of cubic symmetry. It is shown that magneto-ic and thermomagnetoelectric effects measurements alone ot sufficient to establish the band structure of a cubic crystal.

COMPLEX CONDUCTIVITY OF SOME SEMICONDUCTORS.
bstr. 16306

THE DIFFUSION OF IONIZED IMPURITIES IN SEMICONDUC-S. See Abstr. 17566

646 HIGH FREQUENCY GALVANOMAGNETIC EFFECTS. III. J.Tavernier and L.Godefroy.
ys. Radium (France), Vol. 21, No. 8-9, 660-4 (Aug.-Sept., . In French.
The general formulae for the electric conductivity in the nce of a magnetic field are applied to the calculation of tron resonance and the Faraday effect. Formulae giving ffective mass $m^*(\theta)$ for cyclotron resonance, and the Verdet bsorption constants for the Faraday effect are derived.

647 A THEORY OF TRANSPORT ON THE SURFACES OF SEMICONDUCTING FILAMENTS. G.Chobanu.
tverdogo Tela (USSR), Vol. 3, No. 8, 2434-41 (Aug., 1961).
ssian.
The effective mobility of the charge carriers in a semi-ucting filament is evaluated, taking into account the presence of ce charge region near the surface of the filament and assuming drical symmetry. The mobility is evaluated by solving the mann transport equation. The results obtained are applied to ase where the potential of the space charge has a quadratic ndence on the distance from the surface. [English translation oviet Physics—Solid State (USA)]. D.ter Haar

7648 ON THE THEORY OF TRANSPORT PHENOMENA IN SEMICONDUCTORS. J.Kołodziejczak.
phys. Polon. (Poland), Vol. 20, No. 5-6, 379-89 (1961).
On the assumption of an arbitrary energy band structure, the ric current and heat flux are computed. The transport tion is solved by the McClure method (Abstr. 3718 of 1956). The theory of certain thermo- and galvanomagnetic effects is developed on the assumption of a spherical though not necessarily parabolic structure of the bands. The computations deal with the general case of transport by many kinds of carriers.

17649 ON THE THEORY OF FIELD EMISSION FROM SEMICONDUCTORS. R.Fischer, H.Neumann and C.Kleint.
Ann. Phys. (Germany), Vol. 8, No. 3-4, 196-203 (1961). In German.
The theory of field emission from semiconductors is extended to p-type semiconductors at any temperatures. Formulae for the field penetration are deduced. Surface states are not considered. A.J.Fox

17650 FIELD EMISSION FROM SILICON. C.Kleint, H.Neumann and R.Fischer.
Ann. Phys. (Germany), Vol. 8, No. 3-4, 204-19 (1961). In German.
The field emission from p-type silicon single crystals is investigated by observing the emission current—potential characteristics at various temperatures. The results are compared with the theory developed in an earlier article. (See preceding abstract). The observed temperature dependence of the characteristics correspond to the theoretical values for a work function of 5.2 eV. The results are approximate since the effects of surface states, surface layers and the micro-geometry of the surface are neglected. A.J.Fox

17651 THE THEORY OF IMPURITY CONDUCTION. N.F.Mott and W.D.Twose.
Advances in Phys. (GB), Vol. 10, No. 38, 107-63 (April, 1961).
The first part of the paper reviews experimental observations and calculations of impurity conduction in the low concentration region. The reasons for using localized states and a phonon-activated hopping process are discussed. The effect of compensating impurities and disorder is considered and the theory of the interaction of localized carriers with lattice vibrations is traced through from the limits of strong coupling (polar semiconductors) to weak coupling (valence semiconductors). The second part concerns the interaction between carriers in the impurity centres when this becomes large enough to lead to a transition to a metallic form of conductivity. D.J.Huntley

17652 ON THE MECHANISM OF IMPURITY CONDUCTION IN SEMICONDUCTORS. I. THE ACTIVATION ENERGY OF CONDUCTIVITY. J.Mycielski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 193-7 (1961).
A new mechanism for impurity conduction in semiconductors at low temperatures is proposed and the activation energy of conductivity given by this mechanism is calculated. The conductivity arises from carrier jumps over the Coulomb potential wall from the occupied impurity centres to the empty ones. A.J.Fox

17653 ON THE MECHANISM OF IMPURITY CONDUCTION IN SEMICONDUCTORS. II. CONDUCTIVITY IN THE CASE OF STRONG CARRIER—PHONON INTERACTION. J.Mycielski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 3, 199-205 (1961).
The mechanism whereby a carrier jumps from a neutral impurity centre to an ionized one is considered in detail. In the case of strong phonon—carrier interaction the number of excited electrons is high and so the diffusion current between the centres is the limiting factor. The jumping frequency and the conductivity are calculated in the case of small compensation. A.J.Fox

17654 TIME VARIATION OF THE NUMBER OF EXCESS MINORITY CARRIERS IN A SEMICONDUCTOR OF FINITE DIMENSIONS SUBJECT INITIALLY TO A UNIFORM EXCITATION. A.Fortini, L.Gouskov and M.Teboul.
C.R.Acad. Sci. (France), Vol. 252, No. 23, 3541-3 (June 5, 1961). In French.
The excess carriers are supposed to be created at $t = 0$ with uniform density. A one-dimensional model is considered with equal surface recombination velocities on the two faces. The total number of excess carriers at any positive time is worked out with the help of a Laplace tranformation. L.Pincherle

17655 EFFECT OF SURFACE RECOMBINATION ON THE DECAY LAW OF MINORITY CARRIERS IN A SEMICONDUCTOR. A.Fortini, L.Gouskov and M.Teboul.

C.R. Acad. Sci. (France), Vol. 252, No. 26, 4129-31 (June 26, 1961). In French.

Gives a calculation of the total time constant τ for some particular cases. A relation is derived which allows a determination of the surface recombination velocity S by comparing τ of a given specimen with that of a sample with infinite S. L.Pincherle

17656 NEW DERIVATION OF BARDEEN–SHOCKLEY FORMULA FOR MOBILITY OF ELECTRONS IN HOMOPOLAR SEMICONDUCTORS. L.Hrivnák.
Czech. J. Phys., Vol. 10, No. 9, 633-44 (1960).

The Bardeen–Shockley formula for the mobility of an electron or hole in a homopolar semiconductor is derived in a different way to that in which its authors obtained it. The interaction energy of the electron with the acoustic lattice oscillations is derived in an original way. A new possibility for determining the energy gap is given.

17657 CHARACTERISTIC PARAMETERS OF RECOMBINATION CENTRES. S.Koc.
Czech. J. Phys., Vol. 11, No. 7, 523-7 (1961).

Points to the possibility of describing the properties of recombination centres by means of the quantities c_p/c_n and e_n/e_p, in contrast to the existing method based mainly on the so-called energy position of recombination levels. The proposal is supported by a simple statistical analysis and by experimental material and has some advantages over the method used hitherto.

17658 THE THEORY OF THE FIELD EFFECT AT LOW TEMPERATURES. Yu.I.Gorkun.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1061-5 (April, 1961). In Russian.

The space charge and the change of conductivity induced by an electric field are calculated as functions of the band curvature at the surface of a semiconductor for arbitrary filling of local levels. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 722-5 (Oct., 1961)]. D.J.Thouless

17659 THE STATISTICS OF ELECTRONS AND HOLES IN SEMICONDUCTORS WITH DISLOCATIONS.
Yu.V.Gulyaev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1094-1100 (April, 1961). In Russian.

Electrons bound to dislocations are considered to occupy states of a one-dimensional band, giving a theory differing at low temperatures from that of Read (Abstr. 9754 of 1954; 1351 of 1955). The equilibrium occupation of these states is derived in terms of this model, which has two empirical parameters in the simplest case. The trapping rate and its effect on recombination are also considered. The steady trapping rate is evaluated for arbitrary carrier energy. For small energies the pair life-time is deduced. The experimental data of Logan, Pearson and Kleinmann (Abstr. 8125 of 1959) on n-type Ge are used to locate the edge of the assumed band. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 796-800 (Oct., 1961)]. I.D.C.Gurney

17660 A VARIATIONAL METHOD OF DETERMINING ELECTRICAL CONDUCTIVITY FROM A CALCULATION OF THE COULOMB INTERACTION OF THE CARRIERS.
P.M.Tomchuk.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1258-67 (April, 1961). In Russian.

In Landau's calculation of the interelectron interaction (Abstr. 490 of 1937) an expression for the electrical conductivity is obtained which is stationary with respect to variation of the asymmetric part of the distribution function. The electrical conductivity of an electron gas in a semiconductor and a plasma is found. The limits to the application of the approximation of Fröhlich and Paranjape (Abstr. 2144 of 1956) are discussed. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 913-19 (Oct., 1961)]. D.J.Thouless

17661 DIFFUSION OF THE EXCESS CURRENT CARRIERS IN AN ANISOTROPIC CUBIC CRYSTAL IN THE PRESENCE OF A MAGNETIC FIELD. V.N.Dobrovol'skii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1574-80 (May, 1961). In Russian.

For abstract, see Abstr. 14401 of 1961. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 1143-7 (Nov., 1961)].

17662 HEITLER–LONDON APPROACH TO ELECTRICAL CONDUCTIVITY. J.Yamashita.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2215-19 (Oct., 1961). "Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). A Heitler–London approach to electrical conductivity is proposed in order to discuss conduction in semiconductors with incomplete d shells, in which the mobility of carriers is very low. The physical conditions which make the hopping motion of the electrons predominant is examined in detail.

17663 A GRAPHICAL METHOD FOR DETERMINATION OF MOBILITY RATIO IN THE SEMICONDUCTORS FROM HALL EFFECT MEASUREMENTS ONLY. K.Pigoń.
J. appl. Phys. (USA), Vol. 32, No. 11, 2369-71 (Nov., 1961).

A method is presented for the approximate estimation of mobility ratio $b = \mu_n/\mu_p$ from Hall constant measurements taken in the vicinity of the intrinsic region and in this region itself. It is based on a formula giving the Hall constant of a non-degenerate semiconductor at the exhaustion. Examples of such determinations are given and the results obtained show reasonable agreement with other estimates.

17664 A THEORY OF THE EFFECTS OF CARRIER–CARRIER SCATTERING ON MOBILITY IN SEMICONDUCTORS.
T.P.McLean and E.G.S.Paige.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 220-36 (Nov., 1960).

The theory is valid in general at low temperatures where carrier–carrier scattering effects are most important and assumes that the carriers are non-degenerate and move in bands which can be characterized by simple isotropic effective masses. Electron–electron and hole–hole scattering usually produce only small reductions in the mobility although, if ionized impurity scattering were the completely predominant scattering mechanism, they could reduce it by as much as ~ 40%. Electron–hole scattering, mainly due to the opposite drift velocities of the electrons and holes and the consequent drag effect, can produce large effects on the mobility, altering both its magnitude and temperature dependence. These effects are most clearly seen in the minority carrier mobility and their inclusion yields mobilities in substantial agreement with those measured in Ge. In some cases, e.g., holes in n-type InSb, the drag effect is strong enough to give the minority carriers a negative mobility.

17665 STRAIN DEPENDENCE OF THE ACCEPTOR BINDING ENERGY IN DIAMOND-TYPE SEMICONDUCTORS.
P.J.Price.
Phys. Rev. (USA), Vol. 124, No. 3, 713-16 (Nov. 1, 1961).

It is shown that if the acceptor binding energy be expanded in inverse powers of the strain amplitude, $W(\epsilon) = W(\infty) + W_1/\epsilon + \ldots$, then the product $E_S W_1/\epsilon$, where E_S is the strain-induced splitting of the band edge, may be equated to a certain (constant) quantity, which is readily calculable in terms of the infinite-strain acceptor ground state. Z_0 is calculated for germanium with an uniaxial [111] compression. A provisional value of W_1, obtained from the existing data for this case, then gives the result b = 2.9 eV for the appropriate deformation potential constant. An approach to the calculation of W for arbitrary ϵ is suggested.

17666 DEPENDENCE OF THE FREE-CARRIER FARADAY ELLIPTICITY IN SEMICONDUCTORS ON SCATTERING MECHANISMS. J.K.Furdyna and M.E.Brodwin.
Phys. Rev. (USA), Vol. 124, No. 3, 740-4 (Nov. 1, 1961).

The theory of the Faraday ellipticity in semiconductors is developed, via the Boltzmann transport equation, under the assumption of an isotropic energy-dependent time of relaxation τ. Equations relating ellipticity to semiconductor parameters are derived for various ranges of the collision, cyclotron, and applied frequencies. It is observed that, besides its dependence on the value of the scattering parameter, Faraday ellipticity is rather sensitive to the type of scattering mechanism as such, and to the distribution function. Some specific experiments are suggested in the range where ellipticity appears particularly promising as a tool for investigating these aspects of the scattering process. Numerical examples, calculated for thermal and ionized impurity scattering in nondegenerate carrier systems, are contrasted with the results of the constant-τ approximation, showing the inadequacy of the latter approach. Finally, the effect of spheroidal surfaces of constant energy on Faraday ellipticity is briefly discussed.

667 DISTRIBUTION FUNCTIONS FOR HOT ELECTRONS IN MANY-VALLEY SEMICONDUCTORS.
Reik and H.Risken.
Rev. (USA), Vol. 124, No. 3, 777-84 (Nov. 1, 1961).
The Boltzmann equation for electrons in many-valley semiictors, with scattering by acoustical and optical lattice vibra- is solved for high electric fields in the following two cases. ntervalley-scattering is completely negligible. Then in each ular valley, the distribution of the electrons over the energy xwellian for energies of the electrons larger than the energy optical phonon. The corresponding electron temperature s approximately with the square of the electric field strength epends on the angle between the electric field and the longiil axis of the particular valley under consideration. The ron temperatures are therefore in general different in ent valleys. The deviations of the electron distribution from axwellian one for energies of the electrons smaller than the y of an optical phonon are small. (2) If allowance is made transfer of electrons between different valleys a finite ence in the populations is set up even for infinitesimally small valley scattering rate. In addition to this, for finite inter- rate, the electron distribution deviates from the original ellian one. The deviation increases with increasing inter- rate constant, increasing lattice temperature, and increasing ence of the average electron energies in the different valleys. of these effects of intervalley scattering are important for the nation of the field dependence of the Sasaki effect.

668 MAPPING OF THE ELECTRIC STRUCTURE OF SEMICONDUCTOR SURFACES BY THE METHOD OF THE TRON MIRROR. E.Igras.
Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, 403-7 (1961).
A preliminary qualitative study is presented on the above subject eight plates. The latter are primarily of p–n junctions under us conditions of electrical bias. A 5 kV electron beam of 1 to diameter is arranged, by applying suitable potentials, to be cted at, or near to, the highly polished silicon or germanium ce under investigation. Electric inhomogeneity in such a ce will tend to modulate the density of reflected electrons and cture" is produced on a fluorescent screen. Magnification of ximately 100 times is obtained from the electron optics and a r 200 times is achieved optically. It is claimed that the size hape of electric micro-inhomogeneities on semiconductor ces can be established and the dynamics of their changes due mination, heating or an electric field observed directly.
F.A.Baker

669 THE DETERMINATION OF THE CHARACTERISTIC PARAMETERS OF MINORITY CARRIERS IN SEMIUCTORS FROM THE MEASUREMENT OF THE PHOTOUCTIVITY AND PHOTOMAGNETIC EFFECT. Yu.I.Ravich.
Verdogo Tela (USSR), Vol. 3, No. 5, 1601-11 (May, 1961).
ssian.
For abstract, see Abstr. 14426 of 1961. [English translation in: Physics—Solid State (USA), Vol. 3, No. 5, 1162-8 (Nov., 1961)].

niconducting Materials

670 ELECTRICAL AND OPTICAL PROPERTIES OF THE II-V COMPOUNDS.
urner, A.S.Fischler and W.E.Reese.
l. Phys. (USA), Suppl. to Vol. 32, No. 10, 2241-5 (Oct., 1961).
Semiconducting Compounds" Conference Paper, Schenectady, see Abstr. 14428 of 1961). The noncubic II-V semiconductors studied recently by several workers. A review is given of the nt situation. The energy gaps of these materials range from o over 1 eV. Room temperature mobilities of 10-15 000 cm^2 ec^{-1} were observed. Anisotropy of electrical and optical pro-s are reported for several of the compounds. For $CdAs_2$ it is ole to explain the anisotropy of Hall mobility by a simple energy model.

671 SEMICONDUCTING III-V COMPOUNDS.
C.Hilsum and A.C.Rose-Innes.
d, London, New York, Paris: Pergamon Press (1961) 239 pp.
This monograph gives an account of the present state of knowon III-V compounds. Both theoretical and experimental aspects are treated. Chapters are included on band structure, crystal structure, material preparation, electrical properties, optical properties and device applications. The book is mainly intended for readers with some knowledge of semiconductor physics.

17672 GALVANOMAGNETIC EFFECTS IN III-V COMPOUND SEMICONDUCTORS. A.C.Beer.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2107-12 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The influence of various structural characteristics in the III-V compounds on galvanomagnetic properties is discussed. Evidence for the scattering of charge carriers by polar optical modes is reviewed, and the behaviour of Hall and magnetoresistance coefficients is examined in regard to the conduction band structure. Unique characteristics, imparted by light masses in certain bands, include high mobilities and large magnetoeffects associated either with transport in the band or with ionization energies of the impurity centres. The importance of avoiding inhomogeneities, either in the specimen or in the magnetic field, when measuring Hall coefficient or magnetoresistance in high-mobility materials is emphasized. Illustrations are given of the effects of nonuniformities in carrier concentration or in applied magnetic field on various galvanomagnetic phenomena.

17673 MODEL FOR THE ELECTRONIC TRANSPORT PROPERTIES OF MIXED VALENCY SEMICONDUCTORS.
R.C.Miller, R.R.Heikes and R.Mazelsky.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2202-6 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). It is shown that the simple "hopping model" for the transport processes of mixed valency semiconductors is inadequate for impurity concentrations $> \sim 1\%$. In particular, it is necessary to redefine (1) the number of free charge carriers, and (2) the density of available states because of the dominant role played by the impurities in the high concentration range.

17674 HALIDES, OXIDES, AND SULFIDES OF THE TRANSITION METALS. F.J.Morin.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2195-7 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The electrical conductivity and optical absorption data for many compounds of the transition metals suggest that there is a trend from ionic insulators, to metals, to covalent semiconductors as the overlap of atomic orbitals is increased. It is shown that a correlation exists between the electrical behaviour of insulators and metals and the magnitude of the overlap integrals $S(d\epsilon d\epsilon)$ and $S(d\epsilon p\pi)$.

17675 ATOMIC RADII, ELECTRONEGATIVITIES AND ACTIVATION ENERGIES OF COMPOUND INORGANIC SEMICONDUCTORS. J.P.Suchet.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 265-78 (Nov., 1960).
In French.
After the recent study (Abstr. 11682 of 1960) of the importance of the covalent coordination and of the structure type in the prediction of the semiconductivity of inorganic compounds, the author relates the atomic and structural results to the value of the energy gap by means of empirical formulae allowing the computation of the homopolar and heteropolar contributions to this value. The interatomic distances in the C1, DO_3, A7, B1, C6, C33, B29 and DO_{18} structures are used to build three tables of covalent atomic radii for bonds by sp^3, sp^2 and p^3 orbitals, by generalizing Pauling's work on tetrahedral radii, and the homopolar contribution is computed from these radii. The heteropolar contribution is then related to the differences of electronegativity between the atoms and to their atomic numbers. It is shown that Pauling's electronegativity table cannot be used here and another table is built in good agreement with experimental results. Tables give the computed energy gaps and their homopolar and heteropolar parts for about a hundred semiconducting binary compounds.

17676 ORGANIC SEMICONDUCTORS.
J.J.Brophy.
Phys. Today (USA), Vol. 14, No. 8, 40-1 (Aug., 1961).
A report of a two-day conference held in April, 1961 in Chicago under the cosponsorship of the Armour Research Foundation and the magazine "Electronics". The audience of nearly 300, drawn from widely diverse organizations, were treated to eight invited addresses and fourteen contributed papers. The object of the programme was to present a concise summary of the present understanding of a field in which major research activities are only two years old.

17677 INVESTIGATION OF CHANGES IN CHARGE-CARRIER DIFFUSION LENGTH AND ELECTRODE POTENTIAL OF GERMANIUM UNDER ELECTROLYTIC TREATMENT.
P.P.Konorov and M.N.Kolbin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1553-6 (May, 1961).
In Russian.

A special apparatus is described, designed for continuous observation of diffusion length and electrode potential in germanium blanks under anodic and cathodic polarization in various electrolytes (NaOH, KOH, NaCl, KCl, Na_2CO_3, HCl). The diffusion length L_D is measured from the outside of the sample by an optical probe, and the electrode potential φ with the aid of an auxiliary mercury chloride electrode. A schematic outline of the equipment is reproduced and briefly described, and typical L_D and φ are plotted against electrolyte current density for p and n germanium. Results show good agreement with previous investigations by Brattain and Garrett (Abstr. 11067 of 1954) and by Turner [Abstr. 4104 B of 1956; J. Electrochem. Soc. (USA), Vol. 103, No. 4, 252-6 (April, 1956)]. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1127-9 (Nov., 1961)]. A.Landman

17678 THE MEASUREMENT OF THE HALL EFFECT WITH THE AID OF MICROWAVES IN GERMANIUM SPECIMENS CHANGING FROM N-TYPE TO P-TYPE WITH CHANGING TEMPERATURE. T.Stubb.
Acta polytech. Scandinavica, Ph 11 (No.294, 1961) 19 pp.

By means of measurements of the Hall effect in the 3 cm band with various germanium speciments, an absorption was found at 240°K. This absorption is due to the temperature transition of the sample from n-type to p-type. It is shown that the Hall mobility is proportional to $T^{-2.33}$ and that the measured ionization energy is consistent with the value for Al, which is the known doping material in the specimens.

17679 A STUDY OF THE QUANTUM EFFICIENCY OF X-RAY RADIATION ABSORBED IN A P—N JUNCTION.
T.Stubb and R.Graeffe.
Acta polytech. Scandinavica, Ph 13 (No. 302, 1961) 19 pp.

The quantum efficiency of the photoelectric effect was determined by measuring the short-circuit current delivered by a specially designed germanium diode when its carriers were excited with X-rays. An X-ray tube with Cu anode was employed and the background radiation was eliminated with the aid of a Ni filter so that the approximate assumption of monochromatic radiation could be made. The quantum efficiency was found to be 0.18 for 1.54 A wavelength. The life span of the carriers in the diode was determined with the aid of a method involving pulse techniques.

17680 THE EFFECT OF RADIATION ON SEMICONDUCTORS: RECOMBINATION CENTRES INTRODUCED INTO GERMANIUM BY 2 MeV ELECTRONS. P.Baruch.
Ann. Phys. (France), Vol. 6, No. 1-2, 21-79 (Jan.-Feb., 1961).
In French.

Reports a study by a carrier-lifetime technique. In n-type Ge there is an unexpected increase of lifetime with irradiation dose following the initial normal decrease. This may be explained by recombination centres having an energy level of 0.18 eV below the conduction band, and capture cross-sections of 1.9×10^{-15} cm^2 for holes and 0.8×10^{-16} cm^2 for electrons. It is suggested that this recombination centre consists of a lattice vacancy in close association with an interstitial atom. P.A.Walker

17681 HOT ELECTRONS IN GERMANIUM.
K.Seeger.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 32-3. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].

An account of experiments designed to check the field dependence of the conductivity at high fields under various conditions of scattering. Microwave fields were used to avoid having to make contact to the specimen. K.W.Plessner

17682 VERY SLOW CHANGES IN TIME CONSTANT OF RELAXATIONS OF SURFACE CONDUCTIVITY OF GERMANIUM. S.Koc.
Czech. J. Phys., Vol. 11, No. 4, 287-8 (1961).

Some experiments on the d.c. field effect in germanium surfaces are reported. A time constant τ can be associated with the decay of the change in surface conductivity produced by the application of a d.c. field. τ was measured at various times, t, up to 1000 hr after the admission of wet air to the specimen and it was found that τ increased as log t during this period. C.H.G

17683 THE ORIGIN OF SLOW RELAXATION EFFECTS ON GERMANIUM SURFACE WHEN STUDYING THE A.C FIELD EFFECT. S.Koc.
Czech. J. Phys., Vol. 11, No. 4, 289 (1961).

Some experiments on the a.c. field effect in germanium sur are reported. Using a.c. frequencies which were considered sufficiently high to eliminate slow surface state effects, changes in surface conductivity were observed on switching the a.c. field on off. These took the form of a sudden change followed by a slow change, in the same direction, with a time constant of several minutes. C.H.G

17684 THE INFLUENCE OF ADSORBED OXYGEN ON THE LIFETIME OF FREE CHARGE CARRIERS ON GERMANIUM SURFACES. R.Kh.Burshtein and S.I.Sergeev.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 134-6 (July 1, 1961).
In Russian.

The chemisorption of oxygen on the surface of a germanium crystal affects the lifetime, τ, of free charge carriers on the surface. Initial chemisorption is fast, resulting in a monomole layer of GeO; subsequent slower adsorption produces a layer of GeO_2. Measurements of τ were made photogalvomagnetically on n-type germanium at 20° C, after the chemisorption of oxygen in the range 20°-400° C. For oxygen pressures < 0.1 mm. Hg, τ i independent of pressure; for increasing pressures > 0.1 mm. H τ decreases. Variations in τ are compared with the effect on th electronic work function. The slow stage of chemisorption decreases τ and increases the work function. The reduction of GeO_2 to GeO by heating in vacuo has the reverse effect. The re satisfy the theory of Garrett and Brattain, and it is suggested th molecules of GeO_2 are recombination centres for charge carrie D.J.Ba

17685 RECOMBINATION ON ATOMS OF GOLD IN P-TYP GERMANIUM.
V.G.Alekseeva, I.V.Karpova and S.G.Kalashnikov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 964-71 (March, 1961)
In Russian.

The relation between the lifetime of electrons in p-type germanium, containing gold, and the temperature, concentratio equilibrium holes, and concentration of gold atoms, was investi gated experimentally. The experimental results agree very we with the theory of recombination on multiple-charged centres. is found that the effective cross-section of the electrons on neutral gold atoms is 5×10^{-17} cm^2, but on singly-charged negative gold ions it is 2×10^{-10} cm^2. Both depend slightly on temperature. Over the range of temperature used (350-90° K), the gold atoms do not give rise to perceptible trapping. [Englis translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 699-705 (Sept., 1961)]. N.

17686 EFFECT OF THE STATE OF THE SURFACE ON T HALL EFFECT AND THE MAGNETORESISTANCE GERMANIUM. T.N.Sytenko and O.N.Koshel'.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1079-84 (April, 1961).
In Russian.

The change in the magnitude of the Hall e.m.f. and the mag resistance of specimens of germanium were investigated exper mentally in relation to the external electric field. Good agreem with the theory of Petritz and Zemel (1958) was obtained. [Eng translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4 786-9 (Oct., 1961)]. N.

17687 THE ELECTRON CAPTURE CROSS-SECTION FOR ATOMIC MANGANESE IN GERMANIUM.
E.G.Landsberg and S.G.Kalashnikov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1566-70 (May, 1961).
In Russian.

The temperature dependence of the lifetime of electrons in p-type Ge containing manganese was examined in the temperatu range 95° - 330° K using the photoelectromagnetic effect and ph conductivity observations. The capture cross-section for the shallow manganese level was found to be 2×10^{-16} cm^2 (90°K) a the deeper level 4×10^{-17} cm^2 (300°K). Both these values show no temperature dependence. [English translation in: Soviet Ph —Solid State (USA), Vol. 3, No. 5, 1137-40 (Nov., 1961)].

7688 RESISTIVITY OF HEAVILY DOPED GERMANIUM. V.I.Fistul' and A.Ya.Gubenko.
tverdogo Tela (USSR), Vol. 3, No. 5, 1617-19 (May, 1961).
ussian.
For abstract, see Abstr. 10042 of 1961. [English translation in: et Physics—Solid State (USA), Vol. 3, No. 5, 1173-4 (Nov., 1961)].

7689 BAND STRUCTURE PARAMETERS DEDUCED FROM TUNNELING EXPERIMENTS. R.N.Hall and J.H.Racette.
pl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2078-81 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, (see Abstr. 14428 of 1961). Measurements of the voltage and perature dependence of tunnelling in Ge and GaSb are presented h confirm the close proximity of the (000) and (111) conduction edges in these materials. In the case of Ge, the energy separ- of these edges is found to increase with increasing donor con- ration. Tunnelling in the indirect semiconductor GaP shows no ence for indirect (phonon-assisted) tunnelling transitions. It is ved that tunnelling in the junctions which were studied, proceeds deep-level impurities rather than between conduction and val- bands directly, thereby eliminating the requirement of wave ber conservation. Revised values for the zone-centre longitud- optical phonon energies as deduced from tunnelling data in III-V lead salt semiconductors are presented.

7690 CHANGE OF SURFACE STATE OF Ge BY ELECTRON BOMBARDMENT. K.Komatsubara.
ys. Soc. Japan, Vol. 16, No. 1, 125-6 (Jan., 1961).
The change of surface potential produced by irradiation with MeV electrons was measured with Dousmanis' method (Abstr. of 1959). The surface potential started to change when the reached 10^{14}-10^{15} electrons/cm^2. L.Pincherle

7691 LOW-TEMPERATURE ELECTRICAL BREAKDOWN IN GERMANIUM. J.Yamashita.
ys. Soc. Japan, Vol. 16, No. 4, 720-32 (April, 1961).
The low-temperature electrical breakdown effect in n-type Ge h was observed by Sclar and Burstein, Koenig and Gunther-Mohr hem. Phys. Solids (GB), Vol. 2, 1, 268 (1957)], is discussed from point of the hot electron theory. At first, it is assumed that the gy loss of conduction electrons comes only from the acoustic tering, while the mobility is determined by ionized- and neutral rity scatterings besides the acoustic scattering. The electron perature was elevated as a function of applied field and then ate of ionization of donors and the thermal recombination ficient was estimated. By using these values the breakdown of some specimens was calculated and compared with riment. The result of the theory seems to be in good agree- with experiment, when the concentration of donors and ptors is fairly small. The theoretical result is, however, nsistent with experiment, when specimens contain donors e 10^{16} cm^{-3}. Other mechanisms of the energy loss appear to more effectively than acoustic scattering, when the concentra- of the donors is above 10^{18}/cm^{-3}. Further, a mechanism of energy loss is proposed for compensated Ge which leads to a tive resistance.

7692 MEASUREMENT OF SEEBECK EFFECT IN PLASTICALLY BENT GERMANIUM.
mashita and T.Ohta.
ys. Soc. Japan, Vol. 16, No. 8, 1565-9 (Aug., 1961).
The changes of the thermoelectric powers and the electrical stivities of several kinds of n-Ge and p-Ge due to plastic ing were measured in the transition and intrinsic ranges of peratures and were analysed theoretically. The value of the cation-acceptor level is estimated to be about 0.2 eV. The sample near the intrinsic range is converted to p-type by the ing, while n-Ge with low resistivity and p-type samples show ght effect. The change in n–p conversion due to the deformation the thermal conversion is discussed.

7693 SCATTERING OF HOT CARRIERS IN GERMANIUM. E.M.Conwell and A.L.Brown.
ys. Chem. Solids (GB), Vol. 15, No. 3-4, 208-17 (Oct., 1960).
The variation of lattice mobility of hot carriers with their age energy or "temperature" is investigated. An expression is ved for the relaxation time due to single phonon acoustical mode tering which remains valid to very high carrier temperatures at ce temperatures of 20°K and above. In the limit where carriers act mainly with lattice oscillators having only zero point energy found that the relaxation time is proportional to the inverse square of the speed rather than to the inverse first power as for thermal carriers. Lattice mobility is plotted as a function of average carrier energy for various values for the ratio of coupling constants for optical and acoustical modes, and various effective masses, for lattice temperatures of 300°, 78° and 20°K. The effect of dropping the assumption of equipartition of energy among the acoustical lattice oscillators is to increase the scattering effect of the acoustical modes, the more so the lower the lattice temperature, the higher the carrier temperature, and the higher the mass of the carriers. Impurity scattering is not included in the quantitative calculations, but it is shown that the increase in hot-carrier mobility which can be caused by this scattering process will generally be less than has been expected.

17694 THEORY OF OPTICAL RADIATION FROM BREAKDOWN AVALANCHES IN GERMANIUM. P.A.Wolff.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 184-90 (Nov., 1960).
A theory is developed to explain the spectrum of light emitted from avalanching germanium junctions in terms of known properties of the band structure and breakdown process in this material. The low-frequency peak in the spectrum is acribed to intraband transitions by holes near k = 0, higher frequency light arises from electron–hole recombinations. Good agreement with experiment is obtained with a carrier temperature of 0.25 eV and a pair production threshold of 1.5 eV. From the intensity ratio of the two parts of the spectrum an estimate of 10^{19} cm^{-3} is made for the carrier density in the radiating regions.

17695 PHOTON EMISSION FROM AVALANCHE BREAKDOWN IN GERMANIUM P–N JUNCTIONS.
A.G.Chynoweth and H.K.Gummel.
J. Phys. Chem Solids (GB), Vol. 16, No. 3-4, 191-7 (Nov., 1960).
A study was made of the visible and near infrared light emission that occurs at avalanche breakdown in narrow germanium p–n junctions. Similar light has been previously observed in silicon. The spectral distribution of the light was measured for photon energies greater than 1.0 eV compared with that of silicon. The highest photon energies detected by the photomultiplier were about 2.0 eV, about three times the band gap (as is the case in silicon). The emitted intensity increases steadily with wavelength but shows a sharp rise as the photon energy decreases below about 1.2 eV. It is concluded that the high-energy photons are produced by recombinations between electrons and holes of sufficient total kinetic energy while the most likely cause of the increased emission at the low energy and of the spectrum is intravalence band transitions of energetic holes.

17696 THE DRIFT MOBILITY OF ELECTRONS AND HOLES IN GERMANIUM AT LOW TEMPERATURES.
E.G.S.Paige.
J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 207-19 (Nov., 1960).
The drift mobility of electrons and holes was measured in the temperature range from 20° to 300°K in samples of germanium containing impurity concentrations from 7×10^{13} to 4×10^{16} cm^{-3}. Conductivity measurements were also made. Below about 100°K the observed minority carrier mobility is less than the mobility calculated from the effects of scattering by phonons and ionized and neutral impurity atoms. The discrepancy, which is greater than a factor of 2 in some circumstances, is attributed to electron–hole scattering. It is proposed that the unexpectedly large effect of electron–hole scattering is due to a drag exerted on the minority carriers by the majority carriers when an electric field is applied. Qualitative observations on the drift mobility of electrons were made below 20°K. There is no evidence that electrons remain localized about the same minimum in k space for the duration of a transit time ($\frac{1}{2}$ μsec). An extreme example of conductivity modulation of the injected distribution of carriers was observed to occur when impact is taking place. See also Abstr. 17664 of 1961.

17697 DONOR EQUILIBRIA IN THE GERMANIUM–OXYGEN SYSTEM. C.S.Fuller, W.Kaiser and C.D.Thurmond.
J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 301-7 (Jan., 1961).
Donor equilibria involving the reaction of oxygen were determined in a series of oxygen-doped Ge crystals of known oxygen concentrations. The intrinsic electron concentration is shown to be an important factor in determining the equilibrium. The results confirm that four oxygen atoms are involved in the formation of one donor. The standard enthalpy change (71 kcal, 3.1 eV) for the donor formation is somewhat greater than that expected for a GeO_4 structure. The entropy (48 e.u.), however, appears to be much too large for a simple rearrangement model.

17698 TRANSVERSE MAGNETORESISTANCE OF GERMANIUM IN THE QUANTUM LIMIT. T.J.Diesel and W.F.Love.
Phys. Rev. (USA), Vol. 124, No. 3, 666-8 (Nov. 1, 1961).

The transverse magnetoresistance of very pure single-crystal n-type germanium was measured as a function of temperature and magnetic field, in pulsed fields up to 194 kG, in the temperature range from 11° to 78°K. The results below 20°K are obscured by hot electron effects and non-ohmic behaviour of the crystal, but in the quantum limit and above, the magnetoresistance ratio varies linearly with magnetic field above 40 kG and has a T^{-1} temperature dependence. The results of these experiments do not agree with theoretical predictions for various mechanisms.

17699 DEGENERATE GERMANIUM. II. BAND GAP AND CARRIER RECOMBINATION. H.S.Sommers, Jr.
Phys. Rev. (USA), Vol. 124, No. 4, 1101-10 (Nov. 15, 1961).

The data bearing on the band structure of degenerate germanium are abstracted from the literature and intercompared. A variety of effects are described in terms of a voltage characteristic of each. It is found that all the voltages have essentially the same value and show a striking independence of the carrier concentrations. The conclusion is drawn that this voltage closely represents the band gap of degenerate germanium. It is shown that the thermal current at low temperature must be carried by recombination in the junction, which gives the proper barrier if the recombination centres lie near the band edge. This model of recombination explains the thermal current, the minority carrier lifetime, the excess current, and the emission spectrum. The reflectivity peak at 2.2 eV is also consistent if the bands at the [111] edge are roughly parallel to each other. The barrier found from the transition capacitance is not understood. The recombination centres lie close to the band edge. Assuming they are donors and acceptors, their capture cross-section at room temperature is about 10^{-18} cm^2 per neutral atom. On the basis of this model, the thermal gap of highly degenerate germanium is about 30 mV less than for the unperturbed lattice. The shrinkage is independent of temperature.

17700 ELECTRICAL PROPERTIES OF IMPURITY CONDUCTING n-TYPE GERMANIUM.
W.Sasaki and R.de Bruyn Ouboter.
Physica (Netherlands), Vol. 27, No. 9, 877-82 (Sept., 1961).

The electrical resistivity and the magnetoresistance of n-type germanium containing 2.5×10^{17} and 9×10^{17} antimony atoms per cm^3 were measured in the temperature region from 0.54 to 4.2°K. These germanium specimens show anomalous behaviour, i.e. a positive temperature coefficient of resistivity and a negative magnetoresistance effect.

17701 LOW TEMPERATURE ELECTRIC FIELD EFFECTS IN SEMICONDUCTORS. V.V.Paranjape.
Proc. Phys. Soc. (GB), Vol. 78, Pt 4, 516-28 (Oct., 1961).

At liquid helium temperature germanium shows a very strong rise in conductivity with field strength at about 2 V/cm. This process was investigated theoretically on the basis of electron temperature concept. The variation of the density of electrons with field is calculated considering excitation of donors into the conduction band by impact ionization and phonon absorption as well as reverse processes. It is shown that the current, though strongly field dependent, is always stable and an expression for current density as an explicit function of the field strength is obtained. Good agreement with experiments supports the validity of this theory.

17702 MEASUREMENT OF HALL MOBILITY OF GERMANIUM AT A MICROWAVE FREQUENCY.
K.Yamagata and T.Fukuroi.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 3, 247-51 (June, 1960).

The Hall mobility of a specimen of p-type germanium was measured at 9000 Mc/s using a bimodal or dual-mode cavity which had resistive initial-unbalance. The value obtained is of the order of 0.3×10^3 cm^2 V^{-1} sec^{-1}. The difficulty in the accurate determination of the power-level of microwaves limits the accuracy of the measured Hall mobility.

THE SURFACE LEVELS ON GERMANIUM DERIVED FROM PHOTOCONDUCTIVITY DATA IN THE INFRARED SPECTRAL REGION. See Abstr. 17496

EFFECT OF THE STATE OF THE SURFACE ON THE HALL EFFECT AND THE MAGNETORESISTANCE OF GERMANIUM. See Abstr. 17686

17703 THE ANISOTROPIC SCATTERING OF ELECTRONS IONIZED IMPURITIES.
A.G.Samoilovich, I.Ya.Korenblit and I.V.Dakhovskii.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 2, 355-8 (July 11, 1961). In Russian.

The anisotropic scattering of electrons by ionized impuriti can be caused by asymmetry of the scattering potential. This occurs in non-cubic crystals because of the anisotropy of the dielectric constant. The scalar of the dielectric constant is us and the scattering is considered theoretically, with particular reference to germanium and silicon. The variation of the ratio relaxation times, $\tau_{\parallel}/\tau_{\perp}$, with known physical quantities is work out, and the ratio is thus calculated for germanium and silicon. [English translation in: Soviet Physics—Doklady (USA)].

D.J.Ba

17704 USE OF THE PHASE METHOD IN MEASUREMENT THE NON-EQUILIBRIUM CARRIER LIFETIME IN SEMICONDUCTORS. S.V.Bogdanov and B.D.Kopylovskii.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 926-34 (March, 1961). In Russian.

An approximate relation is found connecting the total conc tion of excess carriers in a semiconductor, and the carrier lif velocity of surface recombination, thickness of the specimen, a spectral composition of the exciting beam of light (for the case low injection level). The case of excitation of the excess carri by non-monochromatic light is discussed. The relation derive the form $\tau_m/\tau_0 = f(d/L_m)$, where τ_m and τ_0 are the measured actual life periods, L_m is the measured diffusion length, and d, thickness of the specimen. Tables of results and graphs repre the above relation are given for Si and Ge. [English translatio Soviet Physics—Solid State (USA), Vol. 3, No. 3, 674-9 (Sept., 1

N

17705 ENERGY STRUCTURE OF COMPLEX SEMICONDUCTORS. CALCULATION OF THE BAND STRUCTURE OF Si, Ge AND GaAs BY A SIMPLIFIED ORTHOG IZED PLANE WAVE METHOD. F.M.Gashimzade and V.E.Kha
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1453-7 (May, 1961).

For abstract, see Abstr. 14455 of 1961. [English translati in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1054-7 (N 1961)].

17706 BAND STRUCTURE OF THE INTERMETALLIC SE CONDUCTORS FROM PRESSURE EXPERIMENTS.
W.Paul.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2082-94 (Oct., 1

"Semiconducting Compounds" Conference Paper, Schenect 1961 (see Abstr. 14428 of 1961). Three types of conduction ban extrema in the (000), (100), and (111) directions in k space see determine many of the properties of the group 4 and group 3-5 conductors. Early experimental work on the pressure coefficie of the energy separations of these extrema from the valence ba maximum energy, carried out on Ge (111), (000), (100), Si (100 and InSb (000), suggested that the three pressure coefficients n be independent of the specific element or compound in the grou 4 and group 3-5 series. This work is discussed in detail, and t theoretical basis is briefly considered. All of the completed pressure measurements on these compounds are critically rev and the correlation of unique pressure coefficients with specifi band edges examined. It is demonstrated that pressure experi can be planned to show up details of the band structure unavail for study at atmospheric pressure. Particular attention is pai GaP, and a new model for excess absorption occurring in n -ty samples of this compound and in Si, GaAs, and AlSb is suggest The application of similar techniques to PbS, PbSe, and PbTe i cussed, and results of electrical and optical measurements of energy gap and electron and hole mobilities presented.

17707 THE EFFECT OF COPPER ON THE RECOMBINAT PROCESS IN SILICON, SUBJECTED TO THERMAL TREATMENT. M.I.Iglitsyn and V.N.Mordkovich.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 979-80 (March, 1961). In Russian.

The lifetime of the minority carriers in both n- and p-type silicon specimens was measured by observing the decay of pho conductivity. The specimens were subjected to diffusion of co and rapid cooling from 800°C. It was found that the lifetime of pure samples was decreased by the cooling process. The intro tion of copper resulted in an increase of the lifetime by an amo depending on the diffusion time. A qualitative explanation is gi

ms of the interaction of the impurities with dislocations. ish translation in: Soviet Physics–Solid State (USA), Vol. 3, , 712-13 (Sept., 1961)]. K.N.R.Taylor

708 CHARGE CARRIER RECOMBINATION IN N-TYPE SILICON IRRADIATED WITH γ-RAYS. G.N.Galkin. verdogo Tela (USSR), Vol. 3, No. 2, 630-1 (Feb., 1961). ssian.

ood agreement is reported between values of capture cross- ns for electrons and holes and their temperature dependence ype Si, containing 10^{17}-10^{18} atoms/cm^3 of oxygen, irradiated ast electrons and γ-rays from a Co^{60} source. In both cases ation produced an acceptor level at (E_c – 0.16) eV. [English ation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2, (Aug., 1961)]. G.C.Williams

709 INVESTIGATION OF RECOMBINATION IN SILICON, ALLOYED WITH GALLIUM, INDIUM AND ANTIMONY. Pokrovskii and K.I.Svistunova. verdogo Tela (USSR), Vol. 3, No. 3, 757-67 (March, 1961). ssian.

The Hall effect was measured between 77 and 600°K and the of photoconductivity between 90 and 500°K. Gallium and ony do not affect the recombination rate, which is determin- centres which are beyond control. For indium atoms the -section for electron capture is less than 10^{-19} cm^2 and for capture it is greater than 10^{-18} cm^2. In n-type silicon, alloyed indium and antimony together, trapping by the capture of holes, nized indium atoms, occurs. [English translation in: Soviet ics–Solid State (USA), Vol. 3, No. 3, 551-7 (Sept., 1961)]. R.Berman

710 ACOUSTIC-MODE MOBILITIES FOR "SPLIT P-SILICON". P.J.Price and Yi-Han Kao. . Res. Developm. (USA), Vol. 5, No. 1, 63-4 (Jan., 1961).

The deformation potentials of the upper valence band edge in ed silicon are obtained in terms of the fundamental elements deformation potential operators for the complete valence band m. The principal values of the relaxation time tensor are ated with suitable approximations. L.Pincherle

711 PROPERTIES OF GRAIN BOUNDARIES IN SILICON. Y.Matukura. ys. Soc. Japan, Vol. 16, No. 4, 842-3 (April, 1961).

rom measurements of photovoltage I–V characteristics and coefficient it is concluded that the grain boundary layer in n-type, the electrons originating from uncompleted bonds. G.C.Williams

712 THE ROLE OF OXYGEN IN CRYSTALS OF SILICON. J.P.Suchet. m. phys. (France), Vol. 58, No. 4, 455-63 (April, 1961). ench.

revious work on the nature of the ionic-covalent bonding of conducting materials is reviewed, and its relevance to the n–oxygen bond is discussed. A systematic notation for tural defects and their interactions is developed, based on the al proposals of Rees. Using the proposed notation inter- tions are given of paramagnetic electron resonance, diffusion recipitation processes in aluminium antimonide, gallium onide and silicon, and the thermal treatment of doped crystals. uggested that some donor centres in silicon consist of n atoms occupying different lattice sites and forming different c bonds with their neighbours. The most probable structure donor centre produced by thermal treatment at 450°C is an n atom occupying a normal lattice site, bound to three oxygen in identical interstitial sites. The effects observed after nents at other temperatures may be due to the same ion- cule O_4^+. D.J.Barber

713 HOLE AND ELECTRON MOBILITIES IN DOPED SILICON FROM RADIOCHEMICAL AND CONDUCTIVITY SUREMENTS. K.B.Wolfstirn. ys. Chem. Solids (GB), Vol. 16, No. 3-4, 279-84 (Nov., 1960).

oom temperature (300°K) conductivity mobilities of holes and rons in Ga, As, and Sb doped silicon are calculated from elect- and radiochemical measurements using the effective mass ximation. The concentration range investigated was from 2 × 10^{18} cm^{-3} and from 4 × 10^{15} to 2.5 × 10^{19} cm^{-3} for p- and e silicon respectively. Ionization energies from Hall effect urements and their changes with concentration are estimated for the nondegenerate specimens. Ionization is assumed to be complete in the degenerate cases. In addition, the results are compared with published drift, conductivity and Hall mobilities.

17714 EFFECT OF NEUTRON IRRADIATION ON CARRIER LIFETIME IN Si. K.Matsuura and Y.Inuishi. J. Phys. Soc. Japan, Vol. 16, No. 7, 1485 (July, 1961).

From a study of the decay of photoconductivity of n-type Si irradiated with neutrons it was concluded that shallow trapping centres were introduced: these were not found in γ-irradiated specimens. The activation energy of the trapping centres is higher in pulled Si than in float-zoned Si and the lifetime is more severely reduced in the latter case. G.C.Williams

17715 SURFACE CONDUCTIVITY AND RECOMBINATION AT SILICON–ELECTROLYTE BOUNDARIES. H.U.Harten. Z. Naturforsch. (Germany), Vol. 16a, No. 5, 459-66 (May, 1961). In German.

Measurements of surface conductivity and surface recombination on silicon samples contacted by different electrolytes are reported. From these observations the following conclusions can be drawn: (1) The surface conductivity can be measured without noticeable disturbance due to the electrolyte. (2) A voltage applied between silicon and electrolyte forms accumulation and exhaustion layers at the silicon surface, but no inversion layers. Instead of them depletion layers are formed in which the concentration of both electrons and holes are reduced (non-equilibrium). (3) It is possible that the barrier layer completely takes over a variation ΔU_{El} of the applied voltage. Especially in the exhaustion region the surface potential follows ΔU_{El} exactly. (4) Very thin oxide layers take over part of the applied voltage U_{El}. For small voltages it is proportional to U_{El}, for large voltages it is constant. (5) The measurements of surface recombination on n-type silicon point to an acceptor-type recombination centre about 0.1 eV above the middle of the band gap.

17716 INVESTIGATIONS ON SILICON CARBIDE. H.J.van Daal, C.A.A.J.Greebe, W.F.Knippenberg and H.J.Vink. J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2225-33 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Measurements of Hall effect and resistivity up to 1300°K on p-type hexagonal SiC showed an acceptor level for aluminium of 0.27 eV at zero donor concentration and a not yet identified acceptor level of 0.39 eV. The spin multiplicity of this unknown centre appears to be four times smaller than that of the aluminium centre, so that it may be concluded that this unknown centre in the non-ionized state has paired electrons. Taking a temperature dependence of the level depths proportional to that of the bandgap, the density-of-states effective mass of the holes amounts to 0.59 m_0. The Hall mobility shows at high temperatures the same temperature dependence as that ascribed to scattering of holes by optical phonons. Assuming that optical phonons really come into effect, the behaviour of the Hall mobility in the temperature range from 1300° to 300°K can be explained taking also into account the effect of scattering by acoustical phonons and charged impurities. By a study of I-V characteristics of grown junctions in αSiC and also by applying Roosbroeck–Shockley's theory to the spectral distribution of the p–n luminescence under forward bias, inhomogeneities were found over the junction area. By means of pyrolysis of gaseous compounds of Si and C pure crystals (4 × 2 × 2 mm^3) of "cubic" βSiC were obtained. With the aid of polarized light the existence of a skeleton of a hexagonal twinning system was found in these crystals, the cubic SiC filling up the pores of this skeleton structure.

17717 AlP: PREPARATION, AND ELECTRICAL AND OPTICAL PROPERTIES. H.G.Grimmeiss, W.Kischio and A.Rabenau. J. Phys. Chem. Solids (GB), Vol. 16, No. 3-4, 302-9 (Nov., 1960). In German.

Methods of preparing and doping AlP crystals are described. By measuring the reflectivity and transmission, the band gap of AlP was found to be 2.42 eV at 20°C. Undoped crystals show electroluminescence in bands at 5550 and 6150 A. The electroluminescence is shown to be due to recombination of charge carriers injected from p–n junctions. The peak of the photoluminescence is found at 6100 A. Together with conductivity measurements these results suggest a band picture for undoped AlP. Furthermore, the crystals exhibit point contact rectification and photovoltaic effects. The peak of the photoconductivity is found between 5000 and 5150 A.

17718 SEMICONDUCTIVITY IN ORGANIC MOLECULAR COMPLEXES.
J.A.van der Hoek, J.H.Lupinski and L.J.Oosterhoff.
Molecular Phys. (GB), Vol. 3, No. 3, 299-300 (May, 1960).

Complexes of benzidine or tetramethylbenzidine with iodine, bromine or tetranitromethane were prepared and the electrical conductivities measured at 27°C. The measurements were made on compressed powders by a d.c. method. The accuracies were not good and the complexes were not stoichiometric. The electrical conductivities of the complexes ranged from 10^{-3} ohm^{-1} cm^{-1} for benzidine:I_2 to 10^{-10} ohm^{-1} cm^{-1} for benzidine:Br_2 and tetramethylbenzidine: I_2. J.A.Bornmann

17719 RECENT STUDIES OF BISMUTH TELLURIDE AND ITS ALLOYS. H.J.Goldsmid.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2198-2202 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Reviews the experimental work which has been carried out during the past two years on single crystals of bismuth telluride and its alloys. The combination of experiments on Faraday rotation with those performed previously on galvanomagnetic effects has established that there are 3- and 6-valley band structures associated with p- and n-type Bi_2Te_3, respectively. However, observations of the anisotropy ratio for the electrical conductivity and of the galvanomagnetic coefficients for heavily doped n-type material have shown that the shape of the equal-energy surfaces is dependent on carrier concentration. Similar conclusions have been drawn from the behaviour of the Seebeck coefficient at low temperatures. Measurements on Bi_2Te_3 at low temperatures and on alloys of Bi_2Te_3 have shown that the lattice thermal conductivity is particularly sensitive to the substitution of atoms of I, Se, or S for those of Te. It has also been shown that the anisotropy ratio for the lattice thermal conductivity is almost the same for the alloys as for pure Bi_2Te_3.

ELECTRIC PROPERTIES OF CADMIUM ARSENIDE.
See Abstr. 17811

EXCITON STRUCTURE AND ZEEMAN EFFECTS IN CADMIUM SELENIDE. See Abstr. 17474

17720 THE IONIC CONTRIBUTION TO THE CURRENT THROUGH CdS AT HIGH TEMPERATURES.
K.W.Böer and H.Gutjahr.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 6, 324-7 (1960). In German.

Experiments are described which show that the ionic contribution is less than 1% up to 430° C. C.A.Hogarth

17721 EFFECT OF CURRENT INJECTION ON PROPERTIES OF CADMIUM SULFIDE CRYSTALS. H.Mitsuhashi.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1258-9 (June, 1961).

Ionic bombardment of cadmium sulphide crystals resulted in a large increase in the dark conductivity, and modified the thermally stimulated current curve and the photoconductivity. These effects could be interpreted in terms of changes in the lattice imperfections which act as donors, acceptors, and trapping centres. P.A.Walker

17722 THE INFLUENCE OF CONTACT MATERIALS ON THE CATHODE CONDUCTIVITY OF CADMIUM SULPHIDE AND SELENIDE. A.V.Simashkevich, M.V.Kot and L.M.Panasyuk.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1035-7 (April, 1961). In Russian.

The influence of ohmic and non-ohmic contacts on the distribution of the cathode conductivity along crystals of CdS and CdSe was studied with an electronic probe. An analogy with similar measurements on CdS with a light probe was established. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 752-6 (Oct., 1961)]. D.J.Huntley

DOUBLE PHONON PROCESSES IN CADMIUM SULPHIDE.
See Abstr. 17401

EXCITON STATES AND BAND STRUCTURE IN CdS AND CdSe.
See Abstr. 17475

OPTICAL PROPERTIES OF FREE ELECTRONS IN CdS.
See Abstr. 17864

17723 PREPARATION AND PROPERTIES OF $CdSnAs_2$.
A.J.Strauss and A.J.Rosenberg.
J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 278-83 (Jan., 1961).

N-type samples of $CdSnAs_2$ (m.p. = 590°-600° C) were prepared by freezing from the melt. The highest room temperature Hall mobility attained was 1.2×10^4 cm^2/V sec for a sample with a electron concentration of 5.5×10^{17} cm^{-3}. From infrared absorption data the energy gap is estimated to be approximately 0.23 eV at room temperature. The absorption edge shifts to shorter wavelengths with increasing electron concentration. The electrical and optical data indicate that the conduction band of $CdSnAs_2$ is characterized by a low electron effective mass, of the order of a few hundredths of the free electron mass.

17724 EXCITONS AND BAND SPLITTING PRODUCED BY UNIAXIAL STRESS IN CdTe. D.G.Thomas.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2298 et seq. (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady 1961 (see Abstr. 14428 of 1961). A single exciton peak may be seen in the reflection spectrum of CdTe, a semiconductor with the cubic zinc-blende structure. Some properties of this exciton and of the associated fluorescent phenomena are described. Under uniaxial compressive stress, the single exciton peak splits into two peaks corresponding to the splitting of the $J = \frac{3}{2}$ valence band. The movement of the peaks as a function of stress was determined for four directions of stress in the (110) plane. Within experimental error the splittings are identical for a given stress applied in any direction. Thus, although the material is elastically anisotropic, the splitting may be described by one rather than two deformation potentials. These conclusions are consistent with the polarization properties of the exciton transitions. The polarization properties also show that under compressive stress the $M_J = \pm\frac{1}{2}$ band moves "up" and the $M_J = \pm\frac{3}{2}$ band moves "down".

17725 ELECTRICAL CONDUCTIVITY AND THERMOELECTRIC POWER OF CALCIUM OXIDE. C.H.B.
Nature (GB), Vol. 190, 1093-4 (June 17, 1961).

The electrical conductivity σ of samples of calcium oxide contained between planar nickel cathodes was determined over a range of temperatures T from 550 to 1100°K. Graphs of log σ versus 1/T show the characteristic Loosjes—Vink form (Abstr. 5077 of 1950) with average activation energies for activated samples of 0.7 eV for the low-temperature region and 1.2 eV for the high-temperature region. The average thermoelectric power of calcium oxide in the temperature range 700-1200°K is about 2.4 mV/deg C. C.H.B.

POLARON BAND MODEL AND ITS APPLICATION TO Ce-SEMICONDUCTORS. See Abstr. 17479

17726 THE EFFECT OF OXYGEN ON THE ELECTRIC CONDUCTIVITY OF A CUPROUS OXIDE SINGLE CRYSTAL. R.Kužel.
Czech. J. Phys., Vol. 11, No. 2, 133-40 (1961).

The effect of an excess of oxygen on the electric conductivity of a pre-illuminated and heated single crystal of Cu_2O was investigated. It was found that the influence of illumination on the electric conductivity, together with the concentration of impurities, increases with increasing oxygen pressure during annealing.

17727 ELECTRICAL CONDUCTIVITY OF MONOCRYSTALLINE CUPROUS OXIDE. M.O'Keeffe and W.J.Moore.
J. chem. Phys. (USA), Vol. 35, No. 4, 1324-8 (Oct., 1961).

The electrical conductivity σ of single crystals of cuprous oxide was measured from 25° to 1100° C and at oxygen pressures P_{O_2} from 10^{-5} to 760 mm. Except at very low P_{O_2} the σ at all T is entirely to positive holes associated with native defects (cation vacancies). The different activation energies which occur in different temperature regions can be quantitatively interpreted on this basis. For example, in 1.4 mm O_2 and T above 750° C, $\sigma = 2.3 \times 10^3 \exp(-\epsilon_1/kT)$ with $\epsilon_1 = 0.625$ eV. This $\epsilon_1 = \epsilon_3 + (\Delta H)$ where ΔH is the heat of solution of an atom of oxygen and ϵ_3 is the activation energy for motion of positive holes in an electric field ($\epsilon_3 = 0.295$ eV and $\Delta H = 0.63$ eV). Polycrystalline cuprous oxide doped with beryllium displayed a conductivity consistent with an increase in vacancies and decrease in free positive holes due to incorporation of Be^{2+}.

17728 THE MAGNETORESISTANCE OF P-TYPE SEMICONDUCTING DIAMOND.
P.J.Kemmey and E.W.J.Mitchell.
Proc. Roy. Soc. A (GB), Vol. 263. 420-32 (Sept. 19, 1961).

Measurements of the magnetoresistance at room temperature are described of three oriented semiconducting diamonds. The values obtained for $\Delta\rho/\rho_0 H^2$ are: 2.66×10^{-10} Oe^{-2}, 2.10 and 1.

e longitudinal effects in the [110], [100] and [111], respect- and range from (2.79 to 6.80) × 10^{-10} for the various trans- effects. The components of the magnetoconductive tensor determined from these measurements. The results are com- with calculations carried out for a triple degenerate valence assuming that the energy surfaces can be approximated to by arped spheres and one sphere. These computations are an ex- n of the two-band calculations carried out by Mavroides and Abstr. 5883 of 1958) for germanium. In the approximation des- l the band calculations of Herman (values quoted in Abstr. 6237 9), Hall (Abstr. 3460 of 1958) and Phillips (Abstr. 6237 of 1959) used. The theoretical values of Σ_{xxxx} are within about 30% of perimental values, but the predictions for Σ_{xxyy} and Σ_{xyxy} wer than the values determined experimentally. The amount rping, as indicated by the ratio $\Sigma_{xxxx}/\Sigma_{xxyy}$, required to nt for the experimental values is less than that of the surfaces nich the calculations were made. Thus the measured value of $/\Sigma_{xxyy}$ is 0.51 ± 0.03 while the calculations give 0.80 (Herman), Phillips) and 1.26 (Hall).

729 OPTICAL ABSORPTION EDGE IN GaAs AND ITS DEPENDENCE ON ELECTRIC FIELD. T.S.Moss. l. Phys. (USA), Suppl. to Vol. 32, No. 10, 2136-9 (Oct., 1961). Semiconducting Compounds" Conference Paper, Schenectady, Abstr. 14428 of 1961). Values of the absorption constant ing the range 1 cm^{-1} to 10^4 cm^{-1} were derived from trans- on measurements made on single-crystal gallium arsenide. bsorption edge is very steep up to ~ 4000 cm^{-1}, where there is e beyond which the absorption increases relatively slowly with n energy. The energy bands were calculated using Kane's r. From these a theoretical absorption curve was obtained shows very good agreement with the experimental data. Using insulating material, it was possible to measure the shift of the with applied electric field. The effect is small (~ 200 μ eV or 5000 V/cm field) but is in good agreement with theory.

730 ENERGY OF SPECTRUM AND SCATTERING OF CURRENT CARRIERS IN GALLIUM ARSENIDE. asledov. l. Phys. (USA), Suppl. to Vol. 32, No. 10, 2140-5 (Oct., 1961). Semiconducting Compounds" Conference Paper, Schenectady, see Abstr. 14428 of 1961). Conductivity in impurity bands is ved in gallium arsenide at low temperatures. The impurity ng phenomena observed in n- and p-type crystals are markedly ent due to the wide divergence in their effective masses. In mperature interval where the crystal conductivity is deter- by conduction in the impurity band, resistivity of n-type ial decreases with increasing magnetic field. The tempera- dependences of carrier mobility indicate that at low tempera- he impurity ions play the dominant role of the scattering es. In order to investigate scattering processes more thorough- dies were made of the thermomagnetic Nernst–Ettingshausen s which are very sensitive to the scattering mechanism. It was that, in the case of nondegenerate specimens at low tempera- , scattering by impurity ions dominates, and at high tempera- by acoustical lattice vibrations; scattering by acoustical lattice ions becomes dominant even at low temperature in specimens h degeneracy. Scattering was also investigated in indium ide and indium antimonide.

7731 PROPERTIES OF SEMI-INSULATING GaAs C.H.Gooch, C.Hilsum and B.R.Holeman. l. Phys. (USA), Suppl. to Vol. 32, No. 10, 2069-73 (Oct., 1961). Semiconducting Compounds" Conference Paper, Schenectady, (see Abstr. 14428 of 1961). Most samples of GaAs show pro- es similar to those of germanium and silicon, but it is poss- o prepare GaAs with a resistivity at room temperature great- an 10^6 ohm cm and the electrical properties are then more hose of the wide band gap II-VI compounds, such as CdS. This of material, known as semi-insulating GaAs, previously has een studied thoroughly, partly because homogeneous samples not available. Measurements were made on semi-insulating , and results are reported for carrier concentration and ity as a function of temperature. The interpretation of the ts is sometimes complicated because even at room tempera- he activation energy is about half of the intrinsic activation y, and the carrier concentration can be close to the intrinsic ntration. The dominant lattice scattering mechanism in GaAs ieved to be polar scattering, but even in the purest samples of conducting GaAs made thus far, impurity scattering is observed om temperature. In a highly compensated material like semi- insulating GaAs, neither the Brooks–Herring nor the Conwell–Weisskopf theory of impurity scattering is likely to be valid. An initial study of carrier scattering was made using measurements of transverse magnetoresistance and the field dependence of Hall coefficient.

17732 ELECTRICAL PROPERTIES OF GaSb–InSb ALLOYS. J.C.Woolley and C.M.Gillett. J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 34-43 (Dec., 1960).

Reasonably homogeneous, polycrystalline, solid ingots were produced by slow directional-freezing techniques, and were used to investigate the variation of electrical properties as a function of composition. Values of extrapolated thermal energy gap E_0, electron mobility, and mobility ratio were determined for some 25 specimens covering the complete composition range. Estimates are made of the variation of effective mass values and, by comparison with optical energy gap values, of the energy gap temperature coefficient β. From the variation of mobility with temperature, values of mobility temperature exponent x are obtained. At the InSb-rich end of the composition range, the results indicate a smooth variation of the various parameters with composition, without any appreciable change in the band structure from that of InSb. The results at the GaSb-rich end of the range are complicated, firstly by the presence in GaSb of two conduction bands of only small energy separation, and secondly by an effect which extends over a considerable range of composition and is thought probably to be due to ordering in the alloys. As a result, correlation of the optical and electrical results is difficult in this range of composition.

17733 ENERGY BAND STRUCTURE OF GALLIUM ANTIMONIDE. W.M.Becker, A.K.Ramdas and H.Y.Fan. J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2094-2102 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Resistivity, Hall coefficient, and magnetoresistance were studied for n- and p-type GaSb. The infrared absorption edge was investigated using relatively pure p-type, degenerate n-type, and compensated samples. Infrared absorption of carriers and the effect of carriers on the reflectivity were studied. The magnetoresistance as a function of Hall coefficient for n-type samples at 4.2 °K gave clear evidence for a second energy minimum lying above the edge of the conduction band; the energy separation is equal to the Fermi energy for a Hall coefficient of 5 $cm^3 C^{-1}$. The shift of absorption edge in n-type samples showed that the conduction band has a single valley at the edge, with a density-of-state mass $m_{d_1} = 0.052$ m. By combining the results on the edge shift, magnetoresistance, and Hall coefficient, it was possible to deduce: the density-of-states mass ratio $m_{d_2}/m_{d_1} = 17.3$, the mobility ratio $\mu_2/\mu_1 = 0.06$, and the energy separation $\Delta = 0.08$ eV between the two sets of valleys at 4.2°K. Anisotropy of magnetoresistance, observed at 300°K, showed that the higher valleys are situated along ⟨111⟩ directions. The infrared reflectivity of n-type samples can be used to deduce the anisotropy of the higher valleys; tentative estimates were obtained. Infrared reflectivity gave an estimate of 0.23 m for the effective mass of holes. The variation of Hall coefficient and transverse magnetoresistance with magnetic field and the infrared absorption spectrum of holes showed the presence of two types of holes. Appreciable anisotropy of magnetoresistance was observed in a p-type sample, indicating that the heavy hole band is not isotropic; this was confirmed by the infrared absorption spectrum of holes. The results on the absorption edge in various samples seemed to indicate that the maximum of the valence band is not at k = 0. However, it appears likely that transitions from impurity states near the valence band produced absorption beyond the threshold of direct transitions.

17734 PRESENCE OF CARBON IN GALLIUM PHOSPHIDE CRYSTALS. C.J.Frosch, M.Gershenzon and L.Derick. J. appl. Phys. (USA), Vol. 32, No. 10, 2060-1 (Oct., 1961).

Specimens of GaP prepared in graphite boats in a phosphorus atmosphere are normally highly polycrystalline, and Hall effect analysis shows an acceptor density of 2 × 10^{17} to 5 × 10^{18} cm^{-3} together with some compensating donors. If this material is refined by the floating zone method, one pass is sufficient to produce large crystals with an acceptor concentration of 10^{14}-10^{16} cm^{-3}. This is ascribed to (1) GaP dissolving carbon from the graphite boat, (2) carbon behaving as an acceptor, (3) precipitation of a second carbon-rich phase preventing the growth of large GaP crystals and (4) removal of carbon during floating zone refining. Confirmation is obtained experimentally by radioactive experiments using graphite boats coated with C^{14}. B.R.Holeman

17735 STUDY OF BAND STRUCTURE OF INTERMETALLIC COMPOUNDS BY PRESSURE EXPERIMENTS.
A.Sagar and R.C.Miller.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2073-8 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The effect of hydrostatic pressure on the transport properties of n-type GaSb, InP, GaP, and p-type PbTe was measured to study their band structure. (1) The Seebeck coefficient, Hall coefficient, and resistance of three n-GaSb samples were measured as a function of hydrostatic pressure up to 17 000 atm between 200° and 400°K. The Seebeck coefficient α increased with pressure and approached a constant value at about 10 000 atm. The saturation value of α does not follow the simple $\frac{3}{2}$ InT relation for any of the samples; e.g., for a sample with $R_H(77^\circ K) \cong 95$ coul^{-1}cm^3, the saturation value of α decreases with temperature. The contribution due to the phonon-drag effect is considered as a possible explanation for this phenomenon. (2) The conductivity of p-PbTe increased almost exponentially with pressure both at 300° and 194°K; the Hall coefficient at 300°K decreased by about 5% at at 8000 atm, while the conductivity increased by 55% at this pressure. (3) The resistance of n-InP samples increased with pressure; the pressure coefficient was found to be bigger for samples with higher impurity contents. (4) The resistance of a n-GaP sample decreased by about 3% at 10 000 atm.

17736 AN INVESTIGATION OF THE DEPENDENCE OF THE EFFECTIVE MASS OF ELECTRONS IN N-TYPE InAs ON THE CONCENTRATION OF CURRENT CARRIERS.
F.M.Gashimzade and F.P.Kesamanly.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1255-7 (April, 1961).
In Russian.
Using Kane's dispersion formula [J. Phys. Chem. Solids (GB), Vol. 1, 249 (1957)], expressions are derived for the differential thermoelectric power and for the concentration of current carriers in terms of the reduced Fermi level $\tilde{\mu}$. $\tilde{\mu}$ was derived from the former and m* from the latter for the two extreme cases of scattering by lattice vibrations and by impurity ions. Comparison with a theoretically derived m* suggests that for $n \sim 10^{17}$ scattering by impurities is dominant and the effect of lattice scattering becomes more important at higher concentrations. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 910-12 (Oct., 1961)].
R.Berman

17737 ELECTRICAL AND GALVANOMAGNETIC PROPERTIES OF CRYSTALLINE P-TYPE INDIUM ANTIMONIDE AT LOW TEMPERATURES.
Lyan' Chzhi-Chao [Lien Chih-Ch'ao] and D.N.Nasledov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1458-64 (May, 1961).
In Russian.
For abstract, see Abstr. 11305 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1958-62 (Nov., 1961)].

17738 ELECTRONS AND HOLES IN INDIUM ANTIMONIDE.
J.Kołodziejczak.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 9, No. 4, 293-8 (1961).
On the basis of Kane's results [J. Phys. Chem. Solids (GB), Vol. 1, 249 (1957)], relating to the energy band structure in InSb, the author has evaluated the concentrations of electrons, heavy holes and light holes throughout the temperature range of 200° to 700°K and for different concentrations of the impurities. The values of the intrinsic concentration computed are in good agreement with the experimental results.

17739 ELECTRICAL AND GALVANOMAGNETIC PROPERTIES OF N-TYPE InSb AT LOW TEMPERATURES.
Lyan, Chzhi-chao [Lien Chih-ch'ao] and D.N.Nasledov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1185-9 (April, 1961).
In Russian.
The variation of electrical conductivity and Hall coefficient with temperature have been observed on several specimens of InSb from 4° to 100°K. At liquid helium temperatures, the dependence of the magnetoresistance on magnetic field intensity was investigated for the same specimens. Conduction is observed in an impurity band for specimens with an impurity concentration less than 10^{14} cm^{-3}. A slight maximum in the log R versus T^{-1} curves indicates that the electron mobility in this band is different from that in the conduction band, but decreases rapidly with increase of magnetic field intensity for specimens with an electron concentration of approximately 10^{18}. The magnetoresistance is oscillatory. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 861-4 (Oct., 1961)].
K.N.R.Taylor

17740 INTERBAND FARADAY ROTATION IN III-V COMP
B.Lax and Y.Nishina.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2128-31 (Oct., 1
"Semiconducting Compounds" Conference Paper, Schenect
1961 (see Abstr. 14428 of 1961). Experimental investigation of
Faraday rotation in III-V compounds exhibited a striking singul
at photon frequencies just below the energy gap. A quantum th
retical result associated with the direct transition was develop
to explain the phenomenon. The treatment was extended to inc
forbidden transitons which are readily applicable to such mate
as InAs, GaAs, and GaSb where interband transitions between t
split-off valence bands were observed. The treatment for obse
Faraday rotation by reflection is also considered and experime
results in InSb at optical frequencies are presented. The calcu
are also performed for degenerate semiconductors at low temp
ature.

17741 FREE CARRIER CYCLOTRON RESONANCE, FAR
ROTATION, AND VOIGT DOUBLE REFRACTION I
COMPOUND SEMICONDUCTORS.
E.D.Palik, S.Teitler and R.F.Wallis.
J. appl. Phys. (USA), Suppl. to Vol. 32, No.10, 2132-6 (Oct., 19
"Semiconducting Compounds" Conference Paper, Schenect
1961 (see Abstr. 14428 of 1961). Measurements of cyclotron
resonance absorption were made in the far infrared spectral r
from 25-150 μ on several III-V compounds at room and liquid-
nitrogen temperatures using steady magnetic fields as high as
75kG. For n-type InSb, InAs, InP, and GaAs, the data yield in
tion concerning the conduction electron effective mass at the b
of the band and its variation with magnetic field. Experiments
also carried out on p-type InSb and corresponding information
obtained for light holes. The dependence of the effective mass
both temperature and magnetic field can be satisfactorily inte
preted in terms of Kane's theory for the band structure of thes
materials. Measurements of Faraday rotation and Voigt doubl
refraction were made in the spectral region between 15 and 25
on a number of compound semiconductors at liquid-nitrogen te
atures. Either experiment gives the effective mass of the free
carriers if their concentration is known. If both experiments
be performed, the results can be combined to give both the eff
mass and carrier concentration directly without recourse to e
cal measurements.

17742 BAND STRUCTURE AND TRANSPORT PROPERTI
OF SOME 3-5 COMPOUNDS. H.Ehrenreich.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2155-66 (Oct.,
"Semiconducting Compounds" Conference Paper, Schenect
1961 (see Abstr. 14428 of 1961). The experimental informatio
relevant to the band structure of the compounds InSb, InAs, Ga
GaAs, GaP, AlSb and some of their alloys is synthesized and i
preted in terms of a consistent theoretical picture which explo
the close relationship linking the band structures of the group
3-5 semiconductors. It is shown that the momentum matrix el
determining the conduction band masses in those compounds w
edge is of symmetry type Γ_1, is nearly constant. Simple theor
expressions, agreeing well with experiment, are derived for t
corresponding effective masses and valence band spin—orbit
splittings, following Kane's theory for InSb. The dominant sc
ing mechanisms determining the transport properties are revie
briefly. Arguments are presented which show deformation po
scattering to be unimportant relative to polar optical mode sc
ing. A heuristic treatment indicates that the relaxation time
approximation can be applied reasonably to polar scattering fo
temperatures $T > \hbar\omega_l/K$, where ω_l is the longitudinal optical
quency. Multiband transport effects are discussed with specia
reference to the Nernst effect in GaAs and the electron mobil
GaSb. An explanation of the high-temperature behaviour of th
Nernst coefficient in GaAs in terms of polar and intervalley s
ing is proposed. The mobility in GaSb remains unexplained.

17743 SCATTERING MECHANISMS AND EFFECTIVE M
OF CHARGE CARRIERS IN SEMICONDUCTORS.
APPLICATION TO INDIUM ANTIMONIDE AND MERCURY TELLURIDE. M.Rodot.
Ann. Phys. (France), Vol. 5, No. 7-8 1085-1142 (July-Aug., 19
In French.
Reports measurements of thermomagnetic effects and giv
detailed discussion for the case of InSb, where interaction wit
optical vibrations is found to be the main scattering mechanis
In HgTe interaction with phonons is more important. The the
of the thermomagnetic effects is also reviewed and some new
formulae derived. The effective mass of electrons in HgTe

ases rapidly as the temperature is lowered below 200°K.
L.Pincherle

THIN FILMS OF INDIUM ANTIMONIDE USED AS MAGNETIC ROPROBES. See Abstr. 16480

ALVANOMAGNETIC PROPERTIES OF InSb. ostr. 17621

744 SOME PROPERTIES OF In_2Te_3 AND Ga_2Te_3.
J.C.Woolley and B.R.Pamplin.
ectrochem. Soc. (USA), Vol. 108, No. 9, 874-9 (Sept., 1961).
ummarizes the measurements made to determine various cal parameters for the compounds Ga_2Te_3 and In_2Te_3. The ems of the preparation of stoichiometric In_2Te_3 and Ga_2Te_3 e associated question of ordering of lattice vacancies in are reviewed briefly. Measurements of the thermal coeffic- f expansion of the two compounds at liquid-air and room tem- ures are described. The main section of the work concerns easurements of electrical conductivity and Hall effect in the ounds. The determination of activation energy values from the ical measurements and their relation to the energy gap is ssed, and values of activation energies and also of electron ities are given for ordered and disordered In_2Te_3. It is shown he change in activation energy in In_2Te_3 at 470°C is not associ- vith a change in structure, and an explanation in terms of e in conduction band minimum is considered. Results of pre- ary room temperature measurements of thermal conductivity $_2Te_3$ and ordered In_2Te_3 are given.

745 ELECTRONIC PROPERTIES OF IMIDAZOLE.
S.Aftergut and G.P.Brown.
e (GB), Vol. 191, 379-80 (July 22, 1961).
n energy gap of 2.6 eV was obtained for imidazole using the ion $\rho = \rho_0 \exp(E/2kT)$. This value was compared with an esti- d value of 5 eV for benzene and it was concluded that the gen-bonding of imidazole affects the semiconduction.
J.A.Bornmann

746 ILLUMINATION RECOMBINATION OF HOLES AND ELECTRONS IN PbS, PbSe, PbTe. N.S.Baryshev.
tverdogo Tela (USSR), Vol. 3, No. 5, 1428-30 (May, 1961).
For abstract, see Abstr. 14472 of 1961. [English translation oviet Physics—Solid State (USA), Vol. 3, No. 5, 1037-8 , 1961)].

747 ELECTRICAL PROPERTIES OF LEAD TELLURIDE.
Y.Kanai, R.Nii and N.Watanabe.
l. Phys. (USA), Suppl. to Vol. 32, No. 10, 2146-50 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, (see Abstr. 14428 of 1961). Samples of n-type PbTe crystals different electron concentrations ($n = 2 \times 10^{17} \sim 5 \times 10^{19}$ cm^{-3}) prepared by impurity doping or by heating in the vapour of The electrical properties of these crystals were independent kind of impurities and depended only on the electron concen- n. The electron mobilities of the samples were proportional $^{3/2}$ at 77°K, and $n^{-4/3}$ at 4.2°K. As the conduction electrons in amples are degenerate at these temperatures, the experimental ts mentioned above suggest that the conduction electrons in crystals are scattered mainly by acoustical mode at 77°K and utral imperfections at 4.2°K. Since the electron mobility in becomes very large at 4.2°K (e.g. $1 \sim 4 \times 10^6$ cm^2 $Vsec^{-1}$), this rial is quite suitable for the experimental studies of the quantum port phenomena. To investigate such phenomena, the Hall and etoresistive effects of n-type PbTe crystals were measured at in a pulsed magnetic field up to 170 kG. In the specimens relatively low electron concentrations (e.g. $n \cong 3 \times 10^{17}$ cm^{-3}), agnetoresistive effect had a single minimum at about 77 kG in nsverse magnetic field, and at about 55 kG in a longitudinal This minimum should correspond to the situation where the au level with $l = 1$ coincides with the Fermi level in the PbTe als.

748 OSCILLATORY MAGNETORESISTANCE IN THE CONDUCTION BAND OF PbTe.
Cuff, M.R.Ellett and C.D.Kuglin.
pl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2179-85 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, (see Abstr. 14428 of 1961). Oscillatory behaviour of the trans- magnetoresistance was used to investigate the conduction band ture of PbTe. From the oscillatory periods, it is established he minima in the conduction band consist of four equivalent prolate ellipsoids with a mass anisotropy of approximately 5.5 ocated at the Brillouin zone edge. The decay of the oscillation amplitudes with temperature yields a transverse ellipsoid mass of $m_T^* = (0.030 \pm 0.005)m_0$. High field oscillations were detected that point to the existence of a second band located at the centre of the zone, having a mass of about 0.08 m_0, and lying within ±0.002 eV of the ellipsoid minima. The phase of the oscillations suggests that spin splitting of the Landau levels may be quite large in PbTe.

749 VALENCE BANDS IN LEAD TELLURIDE.
R.S.Allgaier.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2185-9 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The magnetic field dependence of the Hall coefficient at 296° and 77°K, and the temperature dependence of the weak-field Hall coefficient and the resistivity between 296° and 77°K were studied in single-crystal samples of p-type PbTe having carrier concentrations ranging from 4.9×10^{17} to 1.7×10^{19} per cm^3. The Hall data at 77°K are quantitatively consistent with magnetoresistance data which have previously established the presence of $\langle 111 \rangle$ ellipsoids in the valence band. They are not consistent with a low-temperature two-band model, proposed by Stiles from de Haas—van Alphen data at 4.2°K, unless the band edges lie at approximately the same energy (as Stiles found) and unless the carrier mobilities in the two bands are nearly alike. On the other hand, both the Hall and resistivity data above about 150°K do exhibit two-carrier effects suggesting the presence of a lower mobility band at an energy about 0.1 eV below those bands which are occupied at low temperatures.

750 INTERRELATION OF ELECTRONIC PROPERTIES AND DEFECT EQUILIBRIA IN PbTe.
E.Miller, K.Komarek and I.Cadoff.
J. appl. Phys. (USA), Vol. 32, No. 11, 2457-65 (Nov., 1961).
The resistivity, Hall coefficient and Seebeck coefficient of single crystals of PbTe were investigated in the range 77° to 900°K using a capsuling arrangement which prevented tellurium loss from the specimens at elevated temperatures. The low-temperature properties obtained agree with the data reported in the literature. The thermal energy gap obtained from the high-temperature measurements cannot, however, be brought into agreement with the energy gap determined from room-temperature absorption measurements by sole consideration of the excitation of electron—hole pairs across the energy gap at elevated temperatures; it is necessary to include the carriers generated by defect formation at elevated temperatures. Both Schottky—Wagner and Frenkel defects are present, the activation energies for formation of the two types of defects being related by $E_F = \frac{1}{2}E_S + 0.55$ eV $\cong 0.7$ eV.

751 SEMICONDUCTION IN $Li_xNi_{(1-x)}O$.
S.Van Houten.
J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 7-17 (Dec., 1960).
NiO is an insulator, which may be made conducting by the addition of lithium oxide. This behaviour can be explained in terms of an energy level scheme consisting of full, localized Ni^{2+} levels with empty Ni^+ levels approximately 5 eV above them. The consequence of introducing lithium into the lattice is that the Li^+ ions are compensated by Ni^{3+} ions, giving $Li^+ \cdot Ni^{2+}$ acceptor levels at approximately 0·03 eV above the Ni^{2+} levels. Electrical conduction, which is always p-type, may be described in terms of a thermally activated diffusion of holes from one nickel ion to another. The activation energy is connected with self-trapping by the polarization induced by the hopping hole itself. A detailed account is given of the calculation of the energy levels, starting from the ionization energies of the free ions and combining them with Madelung potentials. Corrections are made for the polarization of the lattice and for differences in crystal field stabilization between the Ni ions of different valencies. Measurements of Seebeck effect and electrical resistance as a function of temperature and lithium concentration are discussed in terms of this model. It is shown that the oxygen band, lying much lower than the Ni^{2+} levels, does not give any contribution to the electrical conduction.

752 ELECTRICAL AND OPTICAL PROPERTIES OF MERCURY SELENIDE (HgSe).
H.Gobrecht, U.Gerhardt, B.Peinemann and A.Tausend.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2246-50 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). HgSe single crystals were grown by zone melting. The compound crystallizes in the zinc blende structure and splits into (100) planes. For temperatures ranging from 90° to 500°K conductivity, Hall effect and thermoelectric power were measured; evaporation of HgSe began above 500°K. The lowest carrier concentration of the crystals at 300°K was

3.5×10^{17} cm^{-3}. Only n-type conduction was found. The highest mobility at 300°K was 18 500 cm^2 V^{-1} sec^{-1}. Magnetoresistance showed that the longitudinal effect is very small compared with the transverse. From the photo e.m.f. of the p–n junction Se:HgSe crystal and from the absorption edge of layers the energy gap of 0.5 to 0.75 eV was obtained. Using the thermo-e.m.f. and the absorption an estimation of the effective mass led to 0.04 to 0.07 m_0.

17753 SOME PROPERTIES OF HgSe–HgTe SOLID SOLUTIONS.
M.Rodot, H.Rodot and R.Triboulet.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2254-6 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). $HgTe_{1-x}Se_x$ solid solutions were prepared, with x varying from 0 to 1. The samples are n-type near x = 1 and p-type near x = 0, but, due to the high electron-to-hole mbility ratio, electronic conduction is dominant in the range 100°-400°K in all samples. The concentration of free electrons lies between 5×10^{16} and 3×10^{18} cm^{-3}. Measurements of the Hall mobility μ_H and magnetothermoelectric effect ΔQ show that, for Se-rich samples, lattice scattering is dominant in the range 77°-400°K and that, near room temperature, $\mu_H \propto T^{-2}$. For Te-rich samples, lattice scattering is dominant in the range 200°-400°K and, near room temperature, $\mu_H \propto T^{-1}$. Effective masses were calculated and it is seen that the conduction band is not parabolic. The detailed band structure and the exact value of the mobility seem to depend little upon structural factors. For x = 0.5 and x = 0.9, the electron mobility can reach 12 000 cm^2 V^{-1} sec^{-1} at 293°K and 30 000 cm^2 V^{-1} sec^{-1} at 77°K.

17754 BAND STRUCTURE OF HgSe AND HgSe–HgTe ALLOYS.
T.C.Harman and A.J.Strauss.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2265-70 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). A detailed analysis of Hall coefficient data obtained at temperatures between 77° and 350°K was made for HgSe and $HgSe_{0.5}Te_{0.5}$ samples containing excess donor concentrations up to 10^{19} cm^{-3}. On the basis of previous magnetoresistance, Seebeck coefficient, and reflectivity data, a spherically symmetric non-quadratic conduction band exhibiting the $\epsilon(k)$ dependence described by Kane was adopted in making the analysis. Calculations based on a conventional two-band model failed to give quantitative agreement with experiment, but good agreement was obtained on the basis of a model in which the conduction band and one valence band overlap in energy. Therefore the materials are semimetals rather than semiconductors. The best fit to the data was obtained with an overlap energy of 0.07 eV for both HgSe and $HgSe_{0.5}Te_{0.5}$, with hole density-of-states masses of 0.17 m_0 and 0.30 m_0, respectively. With increasing carrier concentration, the optical absorption edge for heavily doped HgSe exhibits a shift to higher energies which is characteristic of n-type materials with low electron effective masses. Qualitatively, the optical data are consistent with a semimetal band model rather than with a semiconductor model, since the interband absorption edge apparently occurs at photon energies less than the Fermi energy.

ELECTRICAL PROPERTIES OF HgSe–HgTe SYSTEM.
See Abstr. 17813

17755 ON THE SEMICONDUCTING BEHAVIOUR OF NICKEL OXIDE. E.G.Schlosser.
Z. Elektrochem. (Germany), Vol. 65, No. 5, 453-62 (1961). In German.

Results of thermoelectric and conduction measurements for NiO are given in three cases; undoped, Li_2O doped and Ga_2O_3 doped. The conduction type in each case is identified and the trap depths determined. The electron and hole mobilities are also given.

A.J.Fox

17756 THE EMISSION OF HOT ELECTRONS FROM P–N-JUNCTIONS IN SiC CRYSTALS.
M.I.Elinson, G.V.Stepanov and V.I.Pokalyakin.
Radiotekhnika i Elektronika (USSR), Vol. 6, No. 2, 292-7 (Feb., 1961). In Russian.

A study is described of the dependence of the emission of hot electrons from pn-junctions in crystals of SiC on the value of the barrier voltage of the junction and on the temperature. The occurrence of high current density and inhomogeneous distribution of the current over the surface is confirmed. Temperature dependence of the emission was weaker and of a different character from the theoretical result for homogeneous semiconductors of the type Ge or Si. The emission current was found to be closely connected with the transverse current through the junction. J.Berry

17757 ELECTRICAL PROPERTIES OF Ag_2Te.
G.E.Gottlieb, W.M.Kane, J.F.Walsh and C.Wood.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 183-5 (Aug., 19

Hall effect and resistivity measurements were made in t temperature range of 55° K to room temperature on polycryst specimens of β-Ag_2Te. Analysis indicates a band gap of ~0.0 and effective masses and mobilities of electrons and holes ar calculated. B.R.H

17758 RECENT STUDIES ON RUTILE (TiO_2).
H.P.R.Frederikse.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2211-15 (Oct.,

"Semiconducting Compounds" Conference Paper, Schenec 1961 (see Abstr. 14428 of 1961). A review is made of the work reduced and "doped" rutile performed since the appearance of Grant's survey article in the Reviews of Modern Physics (Abs of 1960). Measurements of electrical and optical properties a electron spin resonance spectra are discussed. A model of el tronic bound states and conduction levels is suggested that is patible with the results of these experiments. There is strong dence that the defects in reduced rutile are interstitial Ti^{3+} io At very low temperatures, nearly all electrons are self-trapp cation sites (polarons). As the temperature increases, some these trapped electrons will be excited into the conduction ban The activation energy for this process is approximately 0.007 below 50°K, and about one order of magnitude higher around r temperature. It is concluded that conduction takes place in a 3d band associated with Ti ions; the effective mass at the bott this band is ~ 25 m_0. If one assumes that the polaron binding can be described with a hydrogenic model, one calculates on e ive dielectric constant close to the static value. This result i variance with the commonly accepted ideas concerning electro lattice coupling.

17759 INVESTIGATIONS ON SnS.
W.Albers, C.Haas, H.J.Vink and J.D.Wasscher.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2220-5 (Oct., 1

"Semiconducting Compounds" Conference Paper, Schenec 1961 (see Abstr. 14428 of 1961). The p, T, x diagram of the system was determined especially in the region of the compou The pressure of S_2 in equilibrium with SnS and a liquid phase found to extend over several decades up to 25 mm Hg at the "S rich" side, whereas at the "S-rich" side the S_2 pressures in e rium with solid SnS and a liquid phase lie between 25 mm Hg 100 mm Hg. It was shown that the existence region of solid Sn probably lies entirely at the excess sulphur side. The hole m in a plane perpendicular to the c axis, ≅ 90 cm^2 V^{-1} sec^{-1} at temperature, was proportional to $T^{-2.2}$ for higher temperature The mobility in the direction of the c axis was about five tim smaller. Reversible annealing effects were found for temper above 200°C which could be explained by assuming associatio neutral Sn vacancies. Absorption measurements showed that edge absorption is due to indirect transitions. The bandgap w 1.08 eV at 300°K and 1.115 eV at 77°K. Interband transitions valence band were also found. The effective charge of the ato ($e^* = 0.7\ e_0$) and the effective masses of the holes in the three cipal crystal directions ($m_a^* = m_b^* = 0.20\ m_0$; $m_c^* \cong m_0$) wer determined from reflection measurements in the infrared. F these values and the value for the density of states mass obta means of the Seebeck effect ($m_d^* \cong 0.95\ m_0$), the number of eq maximum of the valence band was found to be at least four.

17760 THE PREPARATION AND THE ELECTRICAL AN OPTICAL PROPERTIES OF SnS CRYSTALS.
W.Albers, C.Haas and F.van der Maesen.
J. Phys. Chem. Solids (GB), Vol. 15, No. 3-4, 306-10 (Oct., 19

SnS crystals were prepared by melting the components in evacuated quartz tube at about 900°C. The observed melting is 880 ± 5°C. The crystals were p-type with a hole density b 10^{17} and 10^{18} cm^{-3} and μ_p = 65 cm^2/V sec at room temperatur of the crystals showed an anomalous behaviour of the Hall coe with temperature similar to what was found recently in SnSe. liminary measurements show that the conductivity in the dire the c-axis is about six times smaller than in the direction pe dicular to the c-axis at room temperature. Analysis of infra transmission measurements at room temperature on cleavage perpendicular to the c-axis reveal the energy gap to be 1.07 ± The free carrier absorption part of the transmission curve sh dependence of $\alpha \sim \lambda^2$; analysis of this curve leads to an effect mass m = 0.4 m_0 for the holes.

'61 ELECTRICAL PROPERTIES OF Sb-DOPED N-TYPE SnSe. J.Umeda.
s. Soc. Japan, Vol. 16, No. 1, 124 (Jan., 1961).
easurements of the electrical resistivity and Hall coefficient
en 100 and 700°K were carried out. The effect on these
ties of heat treatment was also investigated. L.Pincherle

762 FUNDAMENTAL REFLECTIVITY SPECTRUM OF SEMICONDUCTORS WITH ZINC-BLENDE STRUCTURE.
·donа.
l. Phys. (USA), Suppl. to Vol. 32, No. 10, 2151-5 (Oct., 1961).
Semiconducting Compounds" Conference Paper, Schenectady,
see Abstr. 14428 of 1961). The fundamental reflectivity spec-
of several III-V and II-VI semiconductors is discussed and
.red with the reflectivity spectrum of the group IV semicon-
·s. A general feature of these spectra is the presence of two
within the fundamental absorption region. The lower energy
which corresponds to a maximum in the refractive index, can
it into a doublet. This peak is probably due to direct tran-
s between the valence band extrema in the [111] direction at
ge of the Brillouin zone (L point) and the corresponding con-
n band minima. The splitting of this peak corresponds to the
·orbit splitting of the valence band extrema (L_3). The second
corresponds to a maximum in the combined density of states
e transitions. The temperature dependence of these peaks is
liscussed.

763 SOME ELECTRICAL AND OPTICAL PROPERTIES OF ZnSe. M.Aven, D.T.F.Marple and B.Segall.
l. phys. (USA), Suppl. to Vol. 32, No. 10, 2261-5 (Oct., 1961).
Semiconducting Compounds" Conference Paper, Schenectady,
(see Abstr. 14428 of 1961). Single crystals of ZnSe were
.red by the vapour growth technique and optical and electrical
urements on these crystals are reported. Analysis of the
trahlen reflection peak gives 0.026 eV for the transverse
l phonon energy. The longitudinal optical phonon energy is
eV as calculated from the transverse phonon energy, the static
tric constant, $\epsilon_0 = 8.1 \pm 0.3$, and the high-frequency dielectric
ant, $\epsilon_\infty = 5.75 \pm 0.1$. The effective ionic charge calculated
the Szigetti formula is 0.7 ± 0.1. Exciton absorption peaks
iated with the valence and conduction bands in the vicinity of Γ
observed at liquid hydrogen temperature with the principal
at 2.81 ± 0.01 eV. The exciton reduced mass $0.1\ m_0$ combined
he room temperature electron-to-hole mobility ratio of 12
ied by preliminary transport measurements on n- and p-type
gives tentative values of $0.1\ m_0$ and $0.6\ m_0$ for the electron and
masses, respectively. Reflectance was determined by various
ods in the range 0.025 to 14.5 eV photon energy and was analysed
e Kronig–Kramers inversion method to obtain the optical
ants in the 1 to 10 eV range. A number of peaks appear in the
nary part of the dielectric constant. The first set of peaks,
d 3.15 eV, are believed to be due to exciton and interband
itions at Γ with a spin–orbit valence band splitting of 0.45 eV.
econd set of peaks, 4.75 and 5.1 eV, are tentatively assigned to
itions at L with a spin–orbit splitting of 0.35 eV. Other peaks
bserved at higher energies.

7764 REACTIONS OF LITHIUM AS A DONOR AND AN ACCEPTOR IN ZnO. J.J.Lander.
ys. Chem. Solids (GB), Vol. 15, No. 3-4, 324-34 (Oct., 1960).
teactions of oxidized lithium with ZnO were investigated by
s of conductivity measurements. Donors are formed in ZnO if
mosphere surrounding the crystal is reducing. The donor
e is probably the molecular ion LiO^{2-}. Oxidizing conditions
r an acceptor centre presumably obtained by displacement of a
e zinc atom by lithium. Solubilities and diffusion coefficients
measured and some results are reported for the kinetics and
bria of the displacement reaction. High temperatures favour
acement. In one atmosphere of oxygen the Fermi level, which
rmally near the top of the 3.0 eV band gap, can be pushed down
centre of the band gap. Impractically high oxygen pressures
be required to produce strongly p-type material. The precipi-
of lithium on dislocations and their decoration were also
ed.

EXCITONS AND THE ABSORPTION EDGE OF ZnO.
Abstr. 17477

PIEZOELECTRIC SCATTERING AND PHONON DRAG IN ZnO CdS. See Abstr. 17857

Semiconductor Devices

17765 ON AN ESAKI DIODE HAVING THE CURVATURE COEFFICIENT GREATER THAN e/kT.
J.Karlovský and A.Marek.
Czech. J. Phys., Vol. 11, No. 1, 76-8 (1961).

Reports measurements of voltage–current characteristics of Ge tunnel diodes in which the curvature coefficient

$$(d^2I/dV^2)/(dI/dV)_{V=0}$$

which determines the small signal rectification behaviour, exceeds the value e/kT by a factor of more than 2. C.A.Hogarth

17766 EXCESS AND HUMP CURRENT IN ESAKI DIODES. R.S.Claassen.
J. appl. Phys. (USA), Vol. 32, No. 11, 2372-8 (Nov., 1961).

The origin of the excess and hump current in Esaki diodes (Abstr. 2314 of 1958) is described in terms of discrete defect energy levels in the forbidden band. The hump current results from equal-energy transitions of electrons, which originate in a defect level in the n side and tunnel to the valence band on the p side. Impurity conduction is required for appreciable hump currents. The position of the hump locates the defect level if the Fermi level is known for the n side. The excess current is explained in terms of energy-dissipating transitions in which electrons start from a defect location within the junction, tunnel to a virtual state in a localized defect in the p region, and drop to the valence band by impact recombination. A crude derivation by the WKB method relates the logarithm of the excess current to the bias voltage, where the proportionality factor contains the square root of the effective mass of the electron. From current-voltage curves for diodes made of germanium, silicon, and gallium arsenide, the effective electron masses are estimated as 0.01, 0.1, and 0.05 m, respectively. Defect levels in germanium are located at 0.06 and 0.24 eV, in silicon at 0.04 and 0.42 eV, and in gallium arsenide at 0.12 and 0.5 eV below the conduction band. The simultaneous existence of two defect levels can give rise to two distinct slopes of the log I versus V, which were observed in silicon and gallium arsenide diodes following irradiation with 2 MeV electrons.

17767 EXCESS NOISE IN GERMANIUM AND GALLIUM-ARSENIDE ESAKI DIODES IN THE NEGATIVE RESISTANCE REGION. M.D.Montgomery.
J. appl. Phys. (USA), Vol. 32, No. 11, 2408-10 (Nov., 1961).

Low-frequency noise measurements were made throughout the useful bias range of germanium and GaAs Esaki diodes. Evidence is presented, in agreement with Esaki and Yajima (Abstr. 12276 of 1959) that a near square-law relationship exists between the mean-square, short-circuit noise current and excess current for bias voltages beyond the valley voltage in germanium diodes. Attempts to find a similar relationship in GaAs were not conclusive. Noise measurements within the negative-resistance regions of the diodes showed a nearly continuous exponential relationship between excess noise and bias for the germanium units, and a similar plot was obtained for the GaAs diodes, except that a well-defined peak in the noise current was found at about 0.2 eV forward bias. The evidence that the results indicate a rather continuous distribution of allowed states in the forbidden band of the germanium samples and a possible localized maximum in these states in the GaAs samples is discussed.

17768 THE PROBLEM OF REVERSE VOLT–AMP CHARACTERISTICS OF SEMICONDUCTOR DIODES.
G.M.Avak'yants, D.A.Aronov and P.M.Karageorgii-Alkalaev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1400-10 (May, 1961).
In Russian.

Theoretical investigations by Shockley, Sah, Noyce, Tolpygo and Rashba apply to "thick" diodes, with p and n layers exceeding in width by a wide margin the diffusion penetration of minority carriers. Gubanov's theory of a chemical "cut-off" layer applies mainly to very "thin" copper oxide and selenium diodes. The authors propose a general approach in explanation of following effects in "thin" diodes: a relatively rapid growth of reverse current in the saturation region and the occurrence of a differential voltage maximum, which replaces the current theory of shock ionization. A general model of a junction diode is proposed, on which is based a mathematical analysis which does not neglect boundary effects at the metal electrode–semiconductor surface contact and the velocity of surface recombination,

and produces a complicated expression for the V–I relationship. This is thoroughly discussed, and is shown to yield the simpler formulae for thick and very thin diodes as special cases. A satisfactory explanation is given of saturation current characteristics for various semiconductors and different electrode configurations, of temperature anomalies in selenium diodes, of the maximum peak of differential voltage occurring in thin diodes, and methods of calculation of certain characteristics of line depletion layers are indicated. A reasonable agreement with experimental measurements, which are described in some detail, is obtained. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 1016-23 (Nov., 1961)]. A.Landman

17769 EMISSIVE POWER OF A SPHERICAL CONTACT BETWEEN A METAL AND A SEMICONDUCTOR. THE CASE OF STRONG CURRENTS.
Z.S.Gribnikov and K.B.Tolpygo.
Fiz. tverdogo Tela (USSR), Sbornik [Supplement] II, 113-20 (1959) In Russian.

Discusses the equations of ambipolar diffusion in germanium-type semiconductors in the case of a spherically symmetrical contact (p–n junction) and strong currents. For medium currents, the current–voltage characteristics are exponential for injection efficiencies close to unity and parabolic ($I \sim V^2$) for other conditions. When the electron emissive power of the spherical junction is small and currents are very strong, the current–voltage characteristics are semi-cubical parabolae ($I \sim V^{3/2}$). A.Tybulewicz

17770 TEMPERATURE DEPENDENCE OF LOW FREQUENCY FLUCTUATIONS OF CONDUCTIVITY IN REVERSE-BIASED GERMANIUM P-N JUNCTIONS. Yu.S.Karpov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1571-3 (May, 1961). In Russian.

For abstract, see Abstr. 14482 of 1961. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 1141-2 (Nov., 1961)].

17771 THE EFFECT OF THE TYPE OF ION ON THE CHANGES IN THE ELECTRICAL PROPERTIES OF SEMICONDUCTOR SURFACES PRODUCED BY BOMBARDMENT WITH MEDIUM-ENERGY IONS.
M.M.Bredov, V.A.Lepilin, I.B.Shestakov and A.L.Shakh-Budagov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 267-74 (Jan., 1961). In Russian.

Changes in the current–voltage characteristics of a tungsten point in contact with germanium and silicon were produced by irradiation with atomic oxygen and molecular nitrogen ions of 5 and 10 keV. There was a considerable difference between the effects of oxygen and nitrogen ions on the forward and reverse currents and the rectification factor. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 1, 195-9 (July, 1961)]. A.Tybulewicz

17772 ELECTRIC BREAKDOWN OF P–N JUNCTIONS IN SILICON. J.Tauc and A.Abrahám.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 27-31. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].

Observations on the breakdown of junctions in the blocking direction are reported. The emission of electrons, as well as light, during the first stage of breakdown, was measured, while in the second stage electron emission stopped and a single point, glowing red, was found. A thermal breakdown theory is developed which explains this second stage very well. K.W.Plessner

17773 FORWARD CHARACTERISTICS OF SILICON P π N JUNCTIONS. M.Tokunaga and K.Shono.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1029-30 (May, 1961).

Experiments are described in which voltage-current characteristics were measured at 200-500°K for devices with different widths of the high-resistivity (π) region, to test the exponential form of forward characteristics. Activation energies are calculated as 0.6 eV for the generation-recombination current and 1.2 eV for the diffusion current, verifying the basic ideas of Shockley et al., and assuming that the appropriate recombination centres lie near the middle of the forbidden band. C.A.Hogarth.

17774 ON THE SECONDARY TUNNELLING PHENOMENA IN A P–N JUNCTION OF GALLIUM ARSENIDE.
A.Shibata.
J. Phys. Soc. Japan, Vol. 16, No. 6, 1261 (June, 1961).

The fine structure of the I–V characteristics of a GaAs tunnel diode provides evidence for the possible existence of impurity bands in the energy gap, and tunnelling between conduction and valen bands. This fine structure has so far only been observed for specific combination of impurities. A

17775 SOME PROPERTIES OF P–N JUNCTIONS IN GaP H.G.Grimmeiss, A.Rabenau and H.Koelmans.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2123-7 (Oct., 1 "Semiconducting Compounds" Conference Paper, Schenec 1961 (see Abstr. 14428 of 1961). A new method in making sin crystals of GaP and the preparation of diodes is described. T p–n luminescence and photoluminescence of undoped and Zn- GaP were investigated and the light output of the p–n lumines as a function of temperature and excitation density is discuss The spectral sensitivity of the p–n photovoltaic effect was re

17776 SLOW DECAY OF REVERSE CURRENT AND NOI FIELD EFFECT ON Ge P^+–N JUNCTION.
H.Edagawa, Y.Morita, S.Maekawa and Y.Inuishi.
J. Phys. Soc. Japan, Vol. 116, No. 5, 1041-2 (May, 1961).

Slow decay measurements were made with a 50 V junctio bias and ±360 V surface field voltage at temperatures of −70, 20 and 50° C. The decay times increased rapidly with decrea temperature and those for the n-side accumulation and p-side inversion layers were larger than that for the n-side inversio layer. The frequency spectrum of the noise contained a $1/f$ component and the noise/current ratio increased with decrea temperature. D.J.

P–N JUNCTIONS AT VERY LOW TEMPERATURES. See Abstr. 16221

ELECTRON EMISSION FROM REVERSE-BIASED P–N JUNCTIONS IN SiC. See Abstr. 16360

A P–N-JUNCTION RADIATION COUNTER. See Abstr. 16619

17777 ON THE VALIDITY OF THE FORMULA GIVING T SHORT-CIRCUIT CURRENT GAIN OF A TRANSIS IN THE COMMON EMITTER CONNECTION, AS A FUNCTION FREQUENCY. R.Morelière.
C.R. Acad. Sci. (France), Vol. 253, No. 4, 624-5 (July 24, 196 In French.

The formula is verified for various operating points and temperatures from −20 to +30° C. C.A.H

17778 DETERMINATION OF THE IMPURITY DOPING PROFILE OF A TRANSISTOR FROM MEASUREM OF CERTAIN ELECTRICAL CHARACTERISTICS. J.P.Biet.
J. Phys. Radium (France), Vol. 22, Suppl. No. 2, 59A-63A (Feb., 1961). In French.

A method of determining physical parameters of a transi is presented, such as resistivity of the base and the collector shape of the junctions, and base width.

17779 OBSERVATION OF AN ANOMALY IN TRANSISTO CHARACTERISTICS. O.Nakahara.
J. Phys. Soc. Japan, Vol. 15, No. 8, 1537-8 (Aug., 1960).

For a transistor of the "drift" type but with a high-resist "neck" in the base formed by etching, an anomaly is observed curves of V_{ce} as $f(I_c)$ with V_{be} as variable. The collector cu attains a maximum value within the collector voltage saturati region and a further increase in V_{ce} makes I_c decrease. Fin all curves converge to a curve corresponding to I_c for V_{be} = C.A.H

17780 THE DETERMINATION FROM ELECTRICAL MEASUREMENTS OF THE IMPURITY CONCENT TION IN THE BASE REGION OF A LOW FREQUENCY GERM TRANSISTOR. J.P.Biet.
J. Phys. Radium (France), Vol. 22, Suppl. No. 6, 100A-102A (June, 1961). In French.

A method using the relation between collector current an base-emitter voltage is presented. In order to eliminate the influence of temperature an experimental operating mode is g

17781 RADIATION CONVERTER. A.Świt.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 8, No. 8, 459-65 (1960).

Theoretically discusses the solid state image amplifier i which an electroluminescent layer is in series with p–n junct of Ge. The latter operate in the reverse direction under a pu d.c. supply, and have the advantage of a much higher light to

of photocurrent than the usual photoconductor. The operation
e device is analysed with simplifying assumptions, and the
num detectable radiation flux density is calculated to be
W/cm² at 16000 A. If Si junctions are used the value becomes
μW/cm² at 8000 A. S.T.Henderson

782 THE TECNETRON AS A CIRCUIT ELEMENT. A.V.J.Martin.
ys. Radium (France), Vol. 21, Suppl. No. 7, 113A-122A (1960). In French.
continuation of a previous paper (Abstr. 7664 of 1961) in a simplified theory of the tecnetron was developed. The e is now considered as a circuit element in relation with al electronic circuits. Representative equivalent circuits are ished under certain simplifying assumptions. Frequency cteristics are studied, mainly from the viewpoint of variation requency of parameters of interest.

783 GRAPHICAL ANALYSIS OF THE OPERATION OF THE TECNETRON. A.V.J.Martin and J.le Mée.
ys. Radium (France), Vol. 22, Suppl. No. 2, 1A-12A (, 1961). In French.
The tecnetron is a semiconductor amplifying device. It uses ntripetal striction due to the field effect applied to a cylindrical ture and embodies one metal-to-semiconductor rectifying ct. The present paper is an analysis of its operation in the sub- al field region, where the carrier mobility can be considered nstant. It is mainly graphical and is a second approximation analytic theory due to Martin (see preceding abstract). A set versal curves giving the main characteristics of the device is ed. Comparison is made between preceding theories and the nt study.

784 GRAPHICAL ANALYSIS OF THE OPERATION OF THE TECNETRON. II. COMPARATIVE STUDY OF VARIOUS OXIMATIONS. A.V.J.Martin and J.le Mée.
ys. Radium (France), Vol. 22, Suppl. No. 6, 83A-90A (, 1961). In French.

785 HOW HARWELL MAKES SURFACE-BARRIER DETECTORS. G.Dearnaley and A.B.Whitehead.
onics (USA), Vol. 19, No. 1, 72, 74-6 (Jan., 1961).
ilicon crystals are cut to size, etched in a CP4A HF etching on and a thin gold film evaporated on in vacuum. Connections oldered on with flake silver paste. Full details of the process at Harwell are given. R.D.Smith

786 USE OF THE PELTIER EFFECT FOR MAKING TRANSISTOR JUNCTIONS IN A GERMANIUM MONOCRYSTAL LED FROM THE MELT. E.Yu.Kokorish.
llografiya (USSR), Vol. 5, No. 6, 957-8 (Nov.-Dec., 1960). ssian.
The conditions are determined for growing n–p–n junctions in y the application of pulses of direct current between the melt ne crystal whereby the flow of electrons from the melt into the al increases the rate of growth and conversely. Its advantages other methods (easily reversible, instant response, simplicity ipment enabling the process to be made automatic) are dis- d. [English translation in: Soviet Physics—Crystallography , Vol. 5, No. 6, 912-13 (May-June, 1961)]. G.C.Williams

787 STRESS DEPENDENCE OF THE PIEZORESISTANCE EFFECT. D.Long.
l. Phys. (USA), Vol. 32, No. 10, 2050-1 (Oct., 1961).
The statistics of the electron redistribution in semiconductors d by a known change in energy levels is considered, with cular reference to the case where the energy level shift is s-induced. It is concluded that piezoresistance linearity is ly improved by statistical degeneracy and thus heavily doped conductor stress sensors should exhibit better linearity than y doped ones. A.J.Fox

otoconductivity

788 PHOTOELECTRIC EFFECT EXPERIMENT. S.P.Davis.
. J. Phys., Vol. 69, No. 10, 706-7 (Oct., 1961).
An experiment suitable for undergraduates to measure h/e and s described and details of the apparatus and circuit are J.L.Redding

17789 THE EFFECT OF THE CONTACTS ON THE CURRENT–VOLTAGE CHARACTERISTICS OF PHOTOCURRENTS. F.Stöckmann.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 13-15. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].
Contact effects are illustrated by the current–voltage characteristics of barrier-layer photocells, in the dark and under illumination. When carrier injection takes place at the contact, space-charge-limited currents are observed. Measurements on a HgI_2 crystal with one graphite and one gold electrode are reported. K.W.Plessner

17790 THE ROLE OF THE SPATIAL REDISTRIBUTION OF CHARGE IN THE KINETICS OF THE INTERNAL PHOTOEFFECT OF HIGH-RESISTANCE PHOTOCONDUCTORS. A.E.Gershberg.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1384-92 (May, 1961). In Russian.
For abstract, see Abstr. 14500 of 1961. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1004-10 (Nov., 1961)].

PHOTOCONDUCTIVITY OF THIN ANTHRACENE LAYERS IN VACUUM. See Abstr. 17631

17791 THE FUNDAMENTAL PHOTOELECTRIC EFFECT FOR SEMICONDUCTORS AND FOR Cs_3Sb. A.Meessen.
J. Phys. Radium (France), Vol. 22, No. 8-9, 472-80 (Aug.-Sept., 1961). In French.
A theory of the fundamental photoelectric effect is proposed for both direct and indirect transitions from the valence band to the conduction band. Comparison and discussion of experimental results for Cs_3Sb allow one to separate the fundamental photoelectric effect from secondary effects and to suggest new lines for other experimental research. The photoelectric emission depth becomes smaller near the photoelectric threshold because of scattering by impurity centres.

17792 SPACE-CHARGE-LIMITED CURRENTS IN CdS AND ZnS. W.J.Merz.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, p. 17-18. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].
To decide whether true space-charge-limited currents had been observed in CdS crystals, the net charge accumulated within the crystal was measured. Both positive and negative charge was found, depending on the magnitude of the photocurrent which had been passed. This effect is interpreted as due to the change-over in the contact from injecting electrons to acting as a blocking contact, thus leaving the main thesis not proven. K.W.Plessner

17793 THE PHOTOCONDUCTIVITY OF POLYCRYSTALLINE LAYERS OF CADMIUM SULPHIDE. K.V.Shalimova, T.S.Travina and R.R.Rezvyi.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 2, 334-7 (May 11, 1961). In Russian.
A large number of CdS films were made under various atmospheres (vacuum, argon and H_2S) and substrate temperatures and the spectral distribution (200-700 mμ) of the photosensitivity and carrier lifetime measured. To obtain stable photosensitive films, it was found necessary to heat the substrate to at least 300°C and for the resistivity to exceed 100 Ω cm. It was found that the magnitude and spectral distribution of the photosensitivity did not depend on the film thickness, the spectral distribution did not depend on the substrate temperature or the atmosphere, and that increasing the substrate temperature increased the resistivity and the photosensitivity. [English translation in: Soviet Physics—Doklady (USA), Vol. 6, No. 5, 404-6 (Oct., 1961)]. D.J.Huntley

17794 THE CORRELATION BETWEEN THE BACKGROUND AND MAXIMA IN THE FINE STRUCTURE OF THE PHOTOCONDUCTIVITY RESPONSE SPECTRUM IN A MONOCRYSTAL OF CdS. E.F.Gross and B.V.Novikov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1249-52 (April, 1961). In Russian.
It is shown that the maxima and background are a consequence of the complex character of the absorption at the crystal surface. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 906-8 (Oct., 1961)]. K.G.Major

17795 SPECTRAL DEPENDENCE OF THE CHANGE IN THE SURFACE POTENTIAL OF CdSe WITH ILLUMINATION.
L.P.Strakhov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1612-13 (May, 1961).
In Russian.

The surface potential of a thin layer of CdSe changes with the wavelength of the light falling upon it. The potential has a maximum in the visible spectrum and a minimum in the infrared. There is a change of sign near the edge of an absorption band. These phenomena are ascribed to the influence of the internal fields of the crystal on the electrons excited by the illumination. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1169 (Nov., 1961)]. A.E.I. Research Laboratory

17796 THE KINETICS OF THE "EXTERNAL" PHOTO-EFFECT [DIRECTED]FROM METAL TO SEMICONDUCTOR IN PHOTOCELLS.
L.G.Paritskii, A.A.Rogachev and S.M.Ryvkin.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1613-16 (May, 1961).
In Russian.

Low-resistivity CdS single crystals, coated with a layer of electrodeposited Cu (or certain other metals), form photocells which have low inertia, and which display the "external" photo-effect, directed from Cu to CdS. The kinetics of this effect are discussed, and it is shown that its mechanism is similar to the mechanism of the barrier photo-e.m.f. in the presence of a p—n junction. In the former case, the metal in contact with an n-type semiconductor assumes the role of a p-type semiconductor, the role of the minority carriers being taken by those electrons whose energy (after absorption of photons) is higher than the energy of the potential barrier between Cu and CdS. This postulate is supported by experimental evidence. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1170-1 (Nov., 1961)]. M.H.Sloboda

17797 ENERGY TRANSFERS BETWEEN SENSITIZER AND SUBSTRATE. III. SENSITIZATION BY THICK DYE FILMS. R.C.Nelson.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1182-6 (Nov., 1961).

For Pt II, see Abstr. 5719 of 1959. Photoconductivity can be sensitized in cadmium sulphide films by specially prepared films of pinacyanole and kryptocyanine having a thickness ~1 micron. Preparations of this sort offer considerably more opportunity for experiment than those sensitized by monolayers of dyes. Their properties support the validity of the electron-transfer mechanism.

17798 ENERGY TRANSFERS BETWEEN SENSITIZER AND SUBSTRATE. IV. ENERGY LEVELS IN SOLID DYES.
R.C.Nelson.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1186-91 (Nov., 1961).

The work function, or ionization energy, for eight solid dyes was measured. In each case it was found that this energy was equal to the sum of the electron affinity of the dye, as previously measured by the author, and the energy required to produce a charge carrier in the solid dye. The data confirm the point of view that electron-transfer processes in dye sensitization are energetically possible.

17799 FIELD-EFFECT MEASUREMENTS ON SINGLE CRYSTALS OF CdS. F.Eckart and H.Tetsch.
Z. Naturforsch. (Germany), Vol. 16a, No. 7, 717 (July, 1961).
In German.

Experiments designed to investigate surface states on CdS single crystals are reported. The effective mobility of charge carriers for the surface conductivity process was determined as a function of photoconductivity process by the field-effect technique, measuring the change in conductance with an applied field perpendicular to the surface. Measurements were made at constant frequency (250 c/s) and at constant field (4.2 kV/cm) for crystals in atmospheres of hydrogen and of oxygen and in vacuo. The frequency dependence of the effective mobility indicates a relaxation time of the surface states of from 10^{-5} to 10^{-4} sec.
C.H.B.Mee

PHOTOCONDUCTIVITY OF CdS, CdSe AND CdS.CdSe CRYSTALS. See Abstr. 14963

EFFECT OF CURRENT INJECTION ON PROPERTIES OF CADMIUM SULFIDE CRYSTALS. See Abstr. 17721

17800 EXCITON-INDUCED PHOTOCONDUCTIVITY IN Cu_2O. J.H.Apfel and A.M.Portis.
J. Phys. Chem. Solids (GB), Vol. 15, No. 1-2, 33-8 (Aug., 1960).

Structure in the photoconductivity spectrum of Cu_2O was observed which corresponds to the "yellow" exciton series observed in optical absorption. From the fact that the photoconductivit the exciton peaks is initially stimulated by illumination and th quenched, it is concluded that distinct electronic processes a associated with the exciton-induced photoconductivity. The m likely mechanism is excitation of localized carriers by excito The experimental evidence is insufficient to establish that the excitons are mobile. A comparison of d.c. and microwave co ivity measurements of Cu_2O establishes that the conductivity limited by barriers.

17801 INVESTIGATION OF GERMANIUM BY PHOTOELECTRIC METHODS.
V.A.Petrusevich, V.K.Subashiev and G.P.Morozov.
Fiz.tverdogo Tela (USSR), Vol. 3, No. 5, 1505-14 (May, 1961)
In Russian.
For abstract, see Abstr. 11325 of 1961. [English translation Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1091-7 (Nov.

THE SURFACE LEVELS ON GERMANIUM DERIVED FR PHOTOCONDUCTIVITY DATA IN THE INFRARED SPECTRA REGION. See Abstr. 17496

17802 INVESTIGATION OF THE SURFACE OF LEAD SULPHIDE PHOTORESISTORS BY ADSORPTION METHODS. I.A.Berezhnaya and L.N.Kurbatov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1038-43 (April, 196
In Russian.

Measurements were made on the surface of photosensitiv of PbS by the low-temperature adsorption of Xe and the adsorp water vapour. The specific surfaces and structural curves w computed from the adsorption isotherms and it was found that sensitivity photoconducting layers had a relatively small spec surface; this varied from 1 to 7 m^2/g depending on the metho surface preparation. [English translation in: Soviet Physics State (USA), Vol. 3, No. 4, 755-9 (Oct., 1961)]. D.J.

17803 ELIMINATION OF THE EFFECT OF NON-PHOT CONDUCTIVE LAYERS IN STUDIES OF PHOTOCONDUCTIVITY OF MERCURY-BEARING AMORPHOUS SELENIUM FILMS. M.I.Korsunskii, N.S.Pastushuk and G.D.M
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1366-70 (May, 1961)
In Russian.
For abstract, see Abstr. 14517 of 1961. [English transla Soviet Physics—Solid State (USA), Vol. 3, No. 5, 991-4 (Nov.,

17804 INVESTIGATION OF THE STATIONARY PHOTOCONDUCTIVITY AND SURFACE RECOMBINATIO VELOCITY OF SILICON. Yu.A.Kontsevoi and M.I.Iglitsyn.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1465-74 (May, 1961)
In Russian.
For abstract, see Abstr. 14518 of 1961. [English transla Soviet Physics - Solid State (USA), Vol. 1063-9 (Nov., 1961)].

17805 FATIGUE EFFECTS IN SILVER—CAESIUM PHOT CATHODES DUE TO INFRA-RED RADIATION.
Czech. J. Phys., Vol. 10, No. 11, 860-71 (1960). In German.

The fatigue and recovery effects in various types of Ag— photocathodes are described. The photocathodes were irradi at various temperatures with infrared radiation between 0.8 a 2.5 microns. The results are compared with previous experi on fatigue effects due to radiation in the visible spectrum.
J.N.H

Thermoelectric Properties

17806 THERMOELECTRICITY IN METALS AT NORMA TEMPERATURES - A QUERY.
D.K.C.MacDonald and W.B.Pearson.
Proc. Phys. Soc. (GB), Vol. 78, Pt 2, 306-8 (Aug., 1961).

The thermoelectric power in metals is due to electron th diffusion (Se) and to 'phonon drag' (Sg). Rough theoretical es indicate that at room temperature $Sg \cong Se$ whereas experime $Sg \ll Se$. Detailed unpublished calculations by Bailyn on Na that some rather precise cancellations of the contributions to from normal and umklapp electron-phonon processes occur a that $Sg \ll Se$: but it is not known whether such cancellations general feature of metals. M.A

THEORY OF SEEBECK EFFECT IN PLASTICALLY DEFORMED SEMICONDUCTORS. T.Ohta.
Soc. Japan, Vol. 16, No. 8, 1561-4 (Aug., 1961).
effects of the reduction of the free electron density due to cation-acceptors and of the scattering due to the space round the dislocation on the thermoelectric power of aterials are investigated theoretically in the impurity and n ranges of temperatures, and they are compared with the ental data for near intrinsic n-Ge in the transition range rature only. In the intrinsic range of temperature the g effect due to the lattice deformation around the dis- is discussed and compared with the experimental data.

A NOTE ON THE THERMOELECTRIC POWER OF MONOVALENT METALS. P.G.Klemens.
urface Conference Paper, Cooperstown, New York, 60 (see Abstr. 11180 of 1961) p. 306-8; Disc., 309-16.
shown that the lattice component of the thermoelectric monovalent metals must be negative at lowest temper- rrespective of the location of the Fermi surface with to the zone boundary.

GNETOELECTRIC AND THERMOMAGNETOELECTRIC S IN SEMICONDUCTORS. See Abstr. 17645

REVIEW OF STUDIES OF THE THERMOELECTRIC PROPERTIES OF GROUP I METALS AT LOW RATURES, CARRIED OUT IN THE NATIONAL RESEARCH L LABORATORIES AT OTTAWA.
on [W.B.Pearson].
dogo Tela (USSR), Vol. 3, No. 5, 1411-24 (May, 1961).
an.
abstract, see Abstr. 14526 of 1961. [English translation et Physics—Solid State (USA), Vol. 3, No. 5, 1024-33 961)].

ORY OF THERMOELECTRIC POWER OF ALKALI METALS. r. 17439

THE TEMPERATURE VARIATION OF THE THERMOELECTRIC PROPERTIES OF Bi_2Te_3:Sb_2Te_3. SOLID ONS. H.Rodot and M.G.Weill.
Radium (France), Vol. 21, No. 5, 502-3 (May, 1960).
h.
electrical resistivity and thermoelectric power were d from 300° to 800°K for alloys based on the composition 70 wt.% Bi_2Te_3 : Sb_2Te_3, but with the Te content varying excess of 4% to a difficiency of 4%. M.A.Taylor

THERMOELECTRIC PROPERTIES OF CADMIUM ARSENIDE (Cd_3As_2) W.Zdanowicz.
ys. Polon. (Poland), Vol. 20, No. 8, 647-56 (1961).
surements of the thermoelectric power of Cd_3As_2 gave 0μV/°C at 25°C with respect to Cu. From the temperature ce of α between 25 and 400°C, the value of the reduced evel and its temperature dependence $\eta = \xi/kT$ was estimat- in the investigated temperature range η was larger than ce it follows that the Fermi level is situated within the on band, and the electron gas in Cd_3As_2 is degenerate. e temperature dependence of η a correction for electron neracy was introduced into the terms of mobility and ation of electrons. The magnitude of effective electron Cd_3As_2 at 25°C amounts to $m_n^* = 0.046\ m_0$. In extrinsic m_n^* is practically constant, while in intrinsic range it changes g to the formula $m_n^*/m_0 \propto T^{0.9}$. A qualitative attempt was en to explain the difference between the width of forbidden ained from the optical absorption edge (0.6 eV) and that from the Hall coefficient and electrical conductivity .

FECT OF CURRENT INJECTION ON PROPERTIES OF M SULFIDE CRYSTALS. See Abstr.

CTRICAL CONDUCTIVITY AND THERMOELECTRIC OF CALCIUM OXIDE. See Abstr. 17725

VOLUME-GRADIENT PHENOMENA AND THE PROBLEM OF THE FULFILMENT OF THE SECOND ELECTRIC RELATION. P.I.Baranskii.
rdogo Tela (USSR), Vol. 3, No. 5, 1616-17 (May, 1961).
an.
surements on a homogeneous germanium specimen show αT in the impurity conduction region. Because of volume-gradient effects this had previously only been found in the intrinsic range. [This work was reported at a conference before the appearance of Kristensen's work (Abstr. 1117 of 1961)]. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 1172-3 (Nov., 1961)]. R.Berman

17813 THERMOELECTRIC PROPERTIES OF THE HgSe—HgTe SYSTEM.
B.Ya.Brach, V.V.Zhdanova and E.Ya.Lev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 786-9 (March, 1961).
In Russian.

The electrical conductivity has a maximum (1990 $ohm^{-1}cm^{-1}$) for a 50–50% mixture, the thermoelectric power varies linearly with composition and the mobility falls away sharply from both ends of the composition range and is fairly constant at 16000 $cm^2 V^{-1} sec^{-1}$ between 30% of each component. The effective masses are tabulated; m^*/m_0 varies between about 0.03 at either end to about 0.045 for a 50–50% mixture. All measurements were at room temperature. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 571-3 (Sept., 1960)]. R.Berman

17814 ELECTRON AND PHONON SCATTERING. THERMOELECTRICITY IN POTASSIUM AND ALLOYS AT VERY LOW TEMPERATURES.
A.M.Guénault and D.K.C.MacDonald.
Proc. Roy. Soc. A (GB), Vol. 264, 41-59 (Oct. 24, 1961).

An experimental study was made at very low temperatures of the thermoelectric power of potassium and alloys with sodium, rubidium and caesium as solutes. The results enable a clear separation to be made between the "electron diffusion" and "phonon drag" components of thermoelectric power. Comparison of the results with theory leads to a number of useful conclusions about phonon and electron scattering in potassium; the authors believe that their results also confirm that the Fermi surface in pure potassium must be nearly spherical and they have drawn conclusions about the influence of rubidium and caesium in distorting the Fermi surface of potassium. Their interpretation of the data on phonon scattering by impurities leads them to consider the possible role of coherent scattering of lattice waves when the impurity concentration becomes fairly high. It appears that of the three impurities, rubidium probably strains the parent lattice least when it is present in solid solution.

17815 THE EFFECT OF DISSOLVED IRON ON THE THERMOELECTRICITY OF SILVER AT VERY LOW TEMPERATURES. W.B.Pearson and I.M.Templeton.
Canad. J. Phys., Vol. 39, No. 7, 1084-6 (July, 1961).

Iron causes a very large characteristic thermoelectric power at low temperatures when dissolved in very dilute concentration in Ag: this is similar to its effect in Cu and Au. M.A.Taylor

Dielectric Properties

17816 CONTRIBUTIONS TO THE SECOND ALL-UNION CONFERENCE ON THE PHYSICS OF DIELECTRICS.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 1, 1-112; No. 2, 114-256 (1960). In Russian.

For abstracts of the papers presented at the above Conference see Abstr. 17900, 18085-6, 18088, 18090, 18105, 19139-42, 19151, 20738, 20951, 20959, 20962, 20964 of 1960; 286, 1123, 1127, 1166, 2370, 3584, 5280, 6242, 11330, 12475, 14392, 14537-9, 14547, 14563 and 14633 of 1961.

17817 DIELECTRIC AFTER-EFFECTS IN CdS CRYSTALS. U.Kümmel.
Abhandl. Deutschen Akad. Wiss. Berlin, Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 19-23. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].

Polarization effects with time constants of the order of a few minutes are reported. These are attributed to an inhomogeneous conductivity within the crystal. Arguments are put forward which predict such conductivity variations. K.W.Plessner

17818 DIELECTRIC INVESTIGATION OF POLYCRYSTALLINE SELENIUM. W.Ludwig.
Monatsber. Deutschen Akad. Wiss. Berlin (Germany), Vol. 2, No. 2, 91-2 (1960). In German.

17819 POLARIZATION AND SPACE-CHARGE-LIMITED CURRENTS IN RUTILE (TiO_2). F.Cardon.
Physica (Netherlands), Vol. 27, No. 9, 841-9 (Sept., 1961).

High-resistivity rutile single crystals were investigated and three effects are described:

1. A depolarization current flowing when an applied voltage is switched off. This current has a very large half-life time and it is shown, by experiments with light, that this effect must be ascribed to the trapping of electrons at a rectifying contact.

2. Space-charge-limited currents in thin flakes from which a density of 4×10^{11} cm^{-3} trapped electrons at the transition voltage was calculated.

3. A "normalizing" effect which consists in a change of conductivity resulting from the application of a high field.

17820 THE CONTROL OF HOMOGENEITY OF A DIELECTRIC BY MEASUREMENT OF THE DIELECTRIC LOSS-ANGLE TANGENT AT ELEVATED TEMPERATURES. C.Benco.
Tecn. Ital., Vol. 25, No. 7, 471-80 (Oct.-Nov., 1960). In Italian.

To control the quality of insulators for large rotating machines, various types of cell may be used for the study of the loss-angle tangent as a function of voltage. The change in this function with varying conditions may be interpreted in terms of the quality of the initial material. C.A.Hogarth

17821 DIELECTRIC DISPERSION IN CRYSTALS OF LITHIUM FLUORIDE. H.Curien and C.Petitjean.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 254-6 (July 10, 1961). In French.

Dielectric loss effects can be readily shown in monocrystalline specimens of LiF above 300° C but the effects are removed by annealing followed by slow cooling to room temperature. Divalent impurities located at lithium vacancies in the crystals form complex dipoles responsible for the relaxation; they are to some extent inhibited by the annealing. C.A.Hogarth

17822 DIELECTRIC LOSS IN POLY-(HEXAMETHYLENE ADIPAMIDE) AND POLY-(HEXAMETHYLENE SEBACAMIDE) AT LOW TEMPERATURES.
M.N.Stein, R.G.Lauttman, J.A.Sauer and A.E.Woodward.
J. appl. Phys. (USA), Vol. 32, No. 11, 2352-7 (Nov., 1961).

The dielectric behaviour of nylons 6-6 and 6-10 was studied in the temperature region −160° to 60° C at frequencies of 0.1 to 100 kc/s. The effects of thermal history, electron irradiation, and post-irradiation annealing on the two dielectric loss peaks found in this frequency-temperature range were explored. Electron irradiation of nylon 6-6 and 6-10 and thermal quenching of nylon 6-6 lowers the γ peak (−70° C at 1 kc/s for 66 nylon) and raises the β peak (+ 15° C for 66 nylon at 1 kc/sec). Post-irradiation annealing of nylon 6-6 or 6-10 irradiated to low doses (25 to 100 mrad) removes the effect of the irradiation on the dielectric behaviour, but on irradiation to high dosages (900-1000 mrad) the dielectric loss values in the region of the β maximum at 0.1 and 1.0 kc/s are greatly reduced. The frequency shifts of the dielectric-loss maxima for all samples give activation energies, in kcal/mole, which fall in the 8-15 range for the β maximum and 9-19 for the γ maximum. These absorption peaks and the effect of various variables on them are discussed in terms of the molecular structure and possible molecular motions responsible for their occurrence.

17823 DIELECTRIC PROPERTIES OF AMMONIUM DIHYDROGEN PHOSPHATE AT VERY HIGH FREQUENCIES.
E.Rushton.
Brit. J. appl. Phys., Vol. 12, No. 8, 417-18 (Aug., 1961).

Ammonium dihydrogen phosphate shows no detectable dielectric dispersion between 10 kc/s and 36 Gc/s. Determinations of the permittivity ϵ at a frequency of 36 Gc/s are described: the values obtained are $\epsilon_{||} = 14.0$ at 21° C and $\epsilon_{\perp} = 57.1$ at 21.5° C, where $\epsilon_{||}$ and $\epsilon_{\perp}$ are the values of permittivity when the applied electric field is parallel with or perpendicular to the optical axis. These values are not measurably different from those obtained at lower frequencies by the author (at 1 Mc/s) and by other workers (at 10 kc/s).

17824 DIELECTRIC α-, β- AND γ-DISPERSIONS IN THE THERMOSETTING PHENOLIC RESINS. Y.Takahashi.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1028-9 (May, 1961).

The frequency dependence of the dielectric permittivity ϵ' and dielectric loss ϵ'' was measured over the frequency range 0.3 c/s to 1 Mc/s and the temperature range −60° to +170° C for a phenolic resin (synthesized from phenol, o-cresol and formaldehyde und aqueous ammonia catalyst) and cured at 200° C. The α-dispersi at low frequencies and high temperatures is attributed to the m of macromolecules of phenolic resin. A β-disperion at 0.3 to 1 (depending on temperature) is interpreted as due to the motions unreacted methylol and amino groups. A γ-dispersion at high frequencies and low temperatures is also found. Comparison i made with results in the literature. R.G.C.A

THE DIELECTRIC CONSTANT OF FILAMENT NYLON.
See Abstr. 16232

17825 AN INVESTIGATION ON DIELECTRIC PROPERTIE OF MIXTURES AT RADIO FREQUENCIES.
B.P.Pradhan and M.N.Sharma.
Proc. Nat. Inst. Sci. India A, Vol. 26, No. 6, 553-68 (Nov. 26, 19

The major formulae suggested for the dielectric constant o a mixture of two components, at least one of which has the form of particles containing many molecules, are related to one anot Assuming this very recently Pradhan and Gupta (Abstr. 9581 of 1960), have derived three different formulae for determining th dielectric constant for three different shaped particles. The validity of these equations is tested and theoretical and experim results are compared. It is found that these results tally quite satisfactorily.

17826 INFLUENCE OF TRACES OF WATER ON THE DIELECTRIC BEHAVIOUR OF SOLID ACETIC ACI
L.Raczy, E.Constant and R.Gabillard.
C.R. Acad. Sci. (France), Vol. 252, No. 17, 2523-5 (April 24, 19
In French.

The use of a new type of automatic bridge circuit for meas ment of complex permittivity at 100 kc/s showed certain unusu features of the acetic acid—water mixture in the solid phase. solid phase with added water possesses very different dielectri properties from the solid pure acid. C.A.Ho

17827 TEMPERATURE DEPENDENCE OF SURFACE POTENTIAL IN SILVER CHLORIDE SINGLE CRYSTALS. H.Wakabayasi.
J. Phys. Soc. Japan, Vol. 15, No. 11, 2000-6 (Nov., 1960).

The temperature dependence is similar to that of AgBr sin crystals. The knee point moves to the higher temperature as t content of Cd in the specimen is increased. The formation ene Frenkel defect and other quantities are obtained. Comparing w the results of ionic conductivity measurements, the intrinsic a the structure-sensitive regions of the AgCl single crystal deter mined by surface potential were found to correspond to those determined by ionic conductivity. From the difference between reciprocals of the knee point temperatures determined by the t methods, the ratio of the mobility of an interstitial silver ion t silver vacancy may be obtained.

17828 PHOTOCAPACITANCE EFFECTS IN ADDITIVELY COLORED ALKALI HALIDE CRYSTALS.
D.Kahn and A.J.Glass.
J. Phys. Chem. Solids (GB), Vol. 17, No. 3-4, 210-19 (Jan., 196

Additively coloured alkali halide crystals are placed betwe current blocking electrodes and an increase in the capacitance and conductance of the crystal is found on illumination. A mea ment of these quantities at frequencies between 2 and 1000 c/s shown that the observed behaviour follows quite closely a linea ed theory developed by Macdonald (Abstr. 457 of 1954; 8081 of 1959). The region of application of the theory was examined exper ally, and results show that the theory may be used for larger applie tages than assumed in the theory. An analysis of the experimental indicates that the field induced electrode breakdown for the lar voltages (~5 V r.m.s.) is of such a nature that the equivalent circuit describing the crystal continues to be valid. This has also been observed by others. Using the results of the theory t mobility of KI and KBr crystals at room temperature was mea These determinations agree substantially with measurements b others using Hall effect methods. Measurements at low freque have revealed phenomena due to the finite recombination rate c conduction electrons and ionized F-centres. From analysis of behaviour, the capture cross-section of an ionized F-centre in was found to be $3{\cdot}1 \times 10^{-15}\sqrt{\gamma}$ cm^2, where γ is the ratio of the effective electron mass (polaron) to the free electron mass. T recombination rate constant in KBr was also measured.

29 DIPOLE ARRANGEMENT IN PEROVSKITE-TYPE FERROELECTRICS. A.Jaśkiewicz.
ys. Polon. (Poland), Vol. 20, No. 4, 281-8 (1961).
method of investigating the dipole arrangement when
xite-type crystals transform from the non-polar to the
tate is proposed. Thermal fluctuations cause thermal
to be formed when the crystal begins to undergo transforma-
thermal dipole thus formed gives rise to an electric field
urrounding favouring some directions for displacement
hbouring ions. Discussion of ABO_3 substances with
ectrically active B ion indicate that there is one possible
ectric arrangement and three antiferroelectric ones. The
or antiferroelectric arrangement is shown to depend on the
ability of the A ion and on the lattice constant.

30 DIELECTRIC RELAXATION AND COUPLING BETWEEN DIPOLES; FERRO- OR ANTIFERROELECTRIC ITIONS. M.J.Lajzerowicz.
cad. Sci. (France), Vol. 253, No. 2, 234-6 (July 10, 1961).
ich.
e case of a linear chain of double potential wells is considered.
into account only the effect of nearest-neighbour interaction
probability of re-orientation of the dipoles, a nonlinear
n is obtained, which may give rise to ferro- or antiferro-
c states in zero field: The logarithm of the relaxation time
linear function of T^{-1} (the reciprocal of the absolute
ature). L.E.Cross

31 FERROELECTRIC AND PIEZOELECTRIC PROPERTIES OF BIOLOGICALLY SIGNIFICANT SUBSTANCES.
nstaedt.
issenschaften (Germany), Vol. 48, No. 13, 465-72 (1961).
man.
review demonstrating the many similarities in properties
n ferroelectrics, electrets and liquid crystals. The nematic
f the liquid crystals is considered analogous to the ferro- or
lectric state, while the smectic phase is considered equival-
n antiferroelectric state. Emphasis is laid throughout on
t that most of the substances under discussion either are
chemicals occurring in nature or are related to naturally
ing substances. K.W.Plessner

32 EFFECT OF γ Co^{60} RADIATION ON THE DIELECTRIC PROPERTIES OF TRIGLYCINE SULPHATE. B.Hilczer.
cad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland),
No. 3, 229-34 (1961).
e Curie point was found to shift linearly with irradiation
lower temperatures, and at the same time the peak
tivity fell. The D/E hysteresis loops first became con-
d, then single straight lines. The results are attributed to
defects blocking the movement of domain walls.
K.W.Plessner

33 NATURE OF THE FERROELECTRIC TRANSITION IN TRIGLYCINE SULFATE.
, S.Detoni and M.Pintar.
Rev. (USA), Vol. 124, No. 4, 1036-8 (Nov. 15, 1961).
e occurrence of linewidth transitions in the proton magnetic
nce spectra of triglycine sulphate, selenate, and fluoberyllate
corresponding Curie points demonstrates that the ferroelectric
ions in these crystals are connected with a rearrangement
basic ionic units in the unit cell. The results of a combined
magnetic and infrared study confirm the crystal structure
ed by Pepinsky and co-workers (Abstr. 13958 of 1959).
r, they show that the ferroelectric transition in triglycine
e and its isomorphs is of the order—disorder type and
lly of the same nature as that in KH_2PO_4. The chief difference
strong coupling of the protonic motion in triglycine sulphate
e motions of heavier groups.

34 FERROELECTRIC DOMAIN DELINEATION IN TRIGLYCINE SULPHATE AND DOMAIN ARRAYS PRO- BY THERMAL SHOCKS.
ynoweth and W.L.Feldmann.
s. Chem. Solids (GB), Vol. 15, No. 3-4, 225-33 (Oct., 1960).
e ferroelectric domains in single crystals of triglycine
te can be delineated with high resolution simply by etching the
in a water bath for a few seconds at room temperature. Both
ls and sides of domains can be revealed where they intersect
perpendicular and parallel to the ferroelectric axis, respectively. With these techniques many totally internal cigar-shaped domains, with their long axes parallel to the ferroelectric axis, have been discovered. It has also been shown that a very regular array of domains is introduced into the crystal when it is subjected to a thermal shock. A cooling shock gives rise to many small spike-shaped nuclei extending into the crystal from the surfaces. A warming shock results in a regular array of considerably larger domains. It seems that in both cases, the driving force that creates these new domains is the field arising from the polarization discontinuities which, in turn, are caused by the transient thermal gradients set up in the crystal when subjected to the thermal shock. The shapes of the spike-shaped domains introduced by the cooling shock agree with those predicted by a, necessarily, idealized model.

DOMAINS IN FERROELECTRIC GLYCINE SULPHATE MONOCRYSTALS. See Abstr. 17543

17835 PERMITTIVITY IN THE PROCESS OF POLARIZATION REVERSAL OF FERROELECTRIC TRIGLYCINE SULPHATE. A.Mísařová and V.Janoušek.
Czech. J. Phys., Vol. 10, No. 9, 687-8 (1960).

Values of ϵ and tan δ were measured at frequencies of 10 to 300 kc/s while the crystal traversed its D/E hysteresis loop at 30 c/s. As in $BaTiO_3$, ϵ passed through anomalously high values during polarization reversal, but ϵ was not a unique function of the re-polarizing current in this case. J.W.Plessner

17836 POLARIZATION OF ROCHELLE SALT UNDER THE ACTION OF SINGLE SQUARE ELECTRICAL PULSES. N.A.Romanyuk and I.S.Zheludev.
Kristallografiya (USSR), Vol. 5, No. 6, 904-11 (Nov.-Dec., 1961).
In Russian.

The method of recording the state of polarization of Rochelle salt crystals proposed by Abe (Abstr. 10232 of 1959) has been improved. The rapid processes of polarization of Rochelle salt under the action of single square electrical pulses was studied, as well as the processes of the spontaneous decay of the polarized state of the specimen. [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 6, 861-7 (May-June, 1961)].

17837 CONTACT FERROELECTRIC EFFECT APPLIED TO PLASTIC FLOW. B.S.Satyanarayana.
Brit. J. appl. Phys., Vol. 12, No. 10, 563-5 (Oct., 1961).

Investigations made on the ferroelectric effect of manganese dioxide show that a phenomenon, dependent on the efficiency of contact of the oxide surface with the electrodes, exists. The apparent changes in the ferroelectric hysteresis loops with pressure on the electrodes were traced experimentally. The apparent contact variation of the ferroelectric effect in manganese dioxide is applied to a comparison of the plastic flows in indentations in metals, the indentations being made by the Vickers hardness diamond pyramid.

17838 FERROELECTRICITY IN THE POTASSIUM FERROCYANIDE GROUP FERROELECTRICS SUBSTITUTED BY DEUTERIUM FOR HYDROGEN. S.Waku, K.Masuno and T.Tanaka.
J. Phys. Soc. Japan, Vol. 15, No. 9, 1698 (Sept., 1960).

Deuterium oxide was used to substitute for water of crystallization in several cyano complexes. The temperature dependence of spontaneous polarization and coercive field of the deuterated complexes is larger than for the normal compounds but the transition temperatures are only slightly changed. C.A.Hogarth

17839 ASYMMETRIC HYSTERESIS LOOP OF SINGLE $BaTiO_3$ CRYSTALS WITH NON-EQUIVALENT ELECTRODES. V.Janovec, B.Březina and A.Glanc.
Czech. J. Phys., Vol. 10, No. 9, 690-1 (1960).

Square loops were obtained with liquid electrodes or evaporated Ag or Au, but not with In, evaporated Al, or silver paste electrodes. Unsymmetrical loops were obtained when one electrode from each group was used, and possible explanations are put forward, based on the effect of space charges under the electrode on polarization reversal. K.W.Plessner

17840 PERMITTIVITY OF BARIUM TITANATE DURING SWITCHING. A.Mísařová and V.Janoušek.
Czech. J. Phys., Vol. 11, No. 6, 465-6 (1961).

The work of Drougard, Funk and Young (Abstr. 279 of 1955) is extended by measurement of the small signal permittivity and loss over a wider frequency range during switching. While the higher frequency values point to a single relaxation frequency of about

30 kc/s, as found in the previous work, measurements down to 5 kc/s merely show a further steady rise in permittivity.

K.W.Plessner

17841 A CONTRIBUTION TO THE STATICS OF 90° WEDGE-SHAPED DOMAINS IN $BaTiO_3$ CRYSTALS.

J.Fousek and B.Březina.

Czech. J. Phys., Vol. 11, No. 4, 261-7 (1961).

The existence of 90° domains of wedge and parallelepiped shape was studied in $BaTiO_3$ crystals of different form. On the basis of a simple model the condition for their origin is discussed.

17842 THE MOTION OF 90° WEDGE DOMAINS IN $BaTiO_3$ IN AN ALTERNATING ELECTRIC FIELD.

J.Fousek and B.Březina.

Czech. J. Phys., Vol.11, No. 5, 344-59 (1961).

The paper deals with the motion of 90° wedge domains in $BaTiO_3$ in an alternating field of 50 c/s. The critical field, the positional hysteresis loops with double asymmetry, the production of wedges with polarization perpendicular to the field and 180° substructure in the wedges were studied. The differences between the behaviour of the wedges and the individual 90° walls are pointed out, which are caused by differences in the energy balance of these formations and by different interactions with 180° processes. The upper limit of contribution of the wedge motion to the initial permittivity is estimated. The results are discussed from the phenomenological point of view.

17843 STUDY OF SOLID-SOLUTION SINGLE CRYSTALS CONTAINING $BaTiO_3$. T.Sakudo.

J. Phys. Soc. Japan, Vol. 15, No. 11, 2112-13 (Nov., 1960).

Electrical measurements including dielectric constant, Curie temperature, spontaneous polarization, coercive field and birefringence are reported for solid solutions containing up to 20 mol.% $PbTiO_3$ in $BaTiO_3$. Measurements were also made on solid solutions of $SrTiO_3$ in $BaTiO_3$, with results in disagreement with previous workers. A.J.Manuel

17844 ON THE ORIGIN OF BARKHAUSEN PULSES IN $BaTiO_3$. R.C.Miller.

J. Phys. Chem. Solids (GB), Vol. 17, No. 1-2, 93-100 (Dec., 1960).

The domain phenomena which give rise to ferroelectric Barkhausen pulses in $BaTiO_3$ were investigated experimentally. Through direct observation of the domain structure, and simultaneously the Barkhausen pulses, specific domain phenomena were correlated for the first time with particular Barkhausen pulse shapes. It is found that Barkhausen pulses occur under a variety of different circumstances. Among these are: the nucleation of a reversed domain, the initial growth step of a small reversed domain, the collision of two reversed domains, and the formation of a small backswitched domain which produces a negative Barkhausen pulse. With the average crystal, each of these origins is operative at some point during polarization reversal. It was also observed with some crystals that Barkhausen pulses continue to occur for times of the order of hours in the absence of an applied field. The duration of the Barkhausen events range from 2 to ~ 300 μsec and the charge involved during the event is of the order of 10^{-13}C. The theoretical aspects of the problem are not treated, but several driving forces which may be responsible for the pulses are suggested.

17845 TWO-PHASE FERROELECTRIC SYSTEMS. I. BARIUM TITANATE–METAL.

K.Leibler and W.Brański.

Acta phys. Polon. (Poland), Vol. 20, No. 5-6, 447-53 (1961).

The dielectric properties of the two-phase ferroelectric–metal systems were investigated. It was found that a considerable increase of the dielectric constant can be obtained by increasing the concentration of the metal admixture. The shape of the increase curve depends upon the kind of admixture and the size and shape of its grains. The Curie temperature does not change within the limits of experimental errors. However, changes in the Curie–Weiss temperature can be observed, accompanied by a change of the Curie–Weiss constant, i.e. by a change in the slope of the paraelectric part of the curve $1/\epsilon_w$.

17846 BREAKDOWN OF CdS CRYSTALS WITH IMPULSE VOLTAGES. J.Dziesiaty.

Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 24-6. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].

Current–voltage curves are given for pulses of width between 3 and 1000 μsec. Both the currents and the breakdown strength are higher than with d.c. fields. This is attributed to the relati uniform field distribution holding under impulse conditions, whe inhomogeneities in the conductivity do not make themselves felt

K.W.Ples

17847 BREAKDOWN OF THIN FILMS. W.Misselwitz.

Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 34-8. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Reg

Current–voltage curves as well as breakdown strengths we measured on vacuum deposited CdS films of thickness 50 mμ to The strength rose with falling film thickness. Using a formula to Fröhlich, values of the mobility were derived from the breal fields, and these were found to fall with increasing field.

K.W.Ples

17848 FLASH-OVER IN AIR AS A MODEL FOR BREAKDO IN INSULATING MATERIALS. F.Obenaus.

Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 39-42. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Reg

Certain analogies between gaseous breakdown in inhomoger fields and the breakdown of solids are drawn. K.W.Ples

17849 QUANTITATIVE MEASUREMENTS ON DISCHARGE IN SOLID INSULATORS IN AN INHOMOGENEOUS FIELD. J.Schmidt.

Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 47-8. In German. Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region .

The pre-breakdown currents from a point embedded in "Plexiglas" (polymethyl imethacrylate) were measured and t accompanying visual phenomena studied. It is suggested that microcracks in the plastic are widened by the gas pressur to discharges from the electrode and further discharges and carbonization then follow in the widened passages.

K.W.Ple

17850 THE BREAKDOWN VOLTAGE OF EPOXY RESINS I INHOMOGENEOUS FIELD. M.Eberhardt.

Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 49-50. In German. [Colloquium o Inhomogeneous Fields in Solid Dielectrics in the Breakdown Re Using an embedded point and a plane electrode, plots of a.c. breakdown voltage against electrode separation were obtained, which were similar to those applying to gaseous breakdown.

K.W.Ples

17851 TIME LAGS IN THE ELECTRICAL BREAKDOWN C GLASS IMMERSED IN WATER.

M.N.Azam and H.Dickinson.

Brit. J. appl. Phys., Vol. 12, No. 8, 419-20 (Aug., 1961).

When measuring the electric breakdown strength of cover glass immersed in deionized water, time lags to breakdown we observed. The mean statistical time lag was (12 ± 1) μsec. T breakdown strength between spherical electrodes was found to (11.4 ± 1) $\times 10^6$ V/cm.

17852 LOW-TEMPERATURE BREAKDOWN IN GERMANI CONNECTED WITH RADIATION DEFECTS.

V.P.Dobrego, A.A.Rogachev, S.M.Ryvkin and I.D.Yaroshetskii.

Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1298-1300 (April, 196 In Russian.

An electrical breakdown was observed associated with defe produced by γ-radiation and fast neutrons. A region of negativ resistance was also observed and believed to be due to the pres of compensation. [English translation in: Soviet Physics–Solid (USA), Vol. 3, No. 4, 940 (Oct., 1961)]. D.J.Hu

17853 BREAKDOWN STRENGTH OF CAESIUM IODIDE. R.Taagepera, R.S.Storey and K.G.McNeill.

Nature (GB), Vol. 190, 994-5 (June 10, 1961).

It is shown that the breakdown field strength F for the cae chloride type crystal lattice of caesium iodide, is related to th interionic distance 'a' by the same equation $Fa^3 = 28(\pm 25\%)$ fou for the commoner halides with sodium chloride type lattices.

W.G.Tow

7854 LEAD ZIRCONATE-TITANATE PIEZOELECTRIC CERAMICS. A.E.Crawford.
. J. appl. Phys., Vol. 12, No. 10, 529-34 (Oct., 1961).
The disadvantages of ceramics based on barium titanate has ted many of the possible applications of this type of piezo- tric material. The Curie point is low and it is inefficient in trochemical conversion. The discovery of the piezoelectric perties of the solid solution ceramics based on lead zirconate lead titanate has stimulated increasing interest in transducer gn. The paper describes the properties and characteristics his new range of materials in terms of their ferroelectric and oelectric effects.

7855 THE INFLUENCE OF AN ELECTRIC FIELD ON THE FREQUENCY OF PIEZOELECTRIC CUTS. K.Hruška.
ch. J. Phys., Vol. 11, No. 2, 150-2 (1961).
The known fact that a change occurs in the frequency of piezo- tric cuts on application of a d.c. electric field cannot be ex- ned by a change in shape and density of the cut due to piezo- tric deformation in an electric field. This paper gives a brief ification of this assertion on the basis of comparison between eoretical estimate and actual measurements on a number of al-plated and non-metal-plated specimens of quartz and DKT. ; therefore concluded that the elastic and piezoelectric coeffic- s cannot be regarded as constants independent of the electric d strength. J.M.Taylor, Jr

7856 EFFECTS OF HIGH STATIC STRESS ON THE PIEZOELECTRIC PROPERTIES OF TRANSDUCER MATERS. H.H.A.Krueger and D.Berlincourt.
coust. Soc. Amer., Vol. 33, No. 10, 1339-44 (Oct., 1961).
Piezoelectric ceramic elements in high-power acoustic trans- ers are subjected to high static as well as dynamic stress. This articularly true of well-matched transducers operating in deep er, since the static stress in the piezoelectric element may be eral times the water pressure. The present study was undertaken n effort to determine the effects of static compressive stress on piezoelectric properties of two commercial lead titanate zirco- e compositions, PZT-4 and PZT-5, and of two barium-titanate positions, commercial Ceramic B (a barium calcium titanate), the composition 88 wt% barium titanate, 12 wt% lead titanate Pb12Ti). The permanent effects of stress exposure, determined ero stress after exposure to a given stress, were found to be e severe with stress parallel to the polar axis than with perpend- ar stress, as expected. Under maintained stress, however, the cts of perpendicular stress are more severe. PZT-4 and Pb12Ti, generally better suited for use as radiating transducers, w effects dependent upon exposure time but independent of the ber of stress cycles. Ceramic B and PZT-5 show effects de- dent upon the number of stress cycles and less dependent upon total period of stress exposure. Of the compositions tested, T-4 and BaPb12Ti were least affected by high static stress, ering relatively little from exposure to stress as high as 15 000 in^2. Of these two compositions, PZT-4 has markedly higher pling (k_{33}~0.64 compared with 0.365) and therefore offers higher nsducer bandwidth.

7857 PIEZOELECTRIC SCATTERING AND PHONON DRAG IN ZnO AND CdS. A.R.Hutson.
ppl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2287-92 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, I (see Abstr. 14428 of 1961). Piezoelectric scattering of con- tion electrons by acoustical phonons is discussed for ZnO and , and approximate values of the mobilities determined by this chanism alone are derived. The phonon drag contribution to the beck effect in ZnO is assumed to arise from crystal-momentum hange between electrons and acoustical phonons by way of the zoelectric interaction alone. Comparison of the results of this umption with the data has led to the discovery of strong piezo- tric phonon scattering from neutral donor states. These two zoelectric scattering mechanisms and an effective electron mass bout 0.32 m, derived from other experiments, provide a model phonon drag in ZnO which agrees with the temperature depend- e and "impurity" dependence of the data and gives the correct gnitude of the effect to within the uncertainties of the approxi- ions employed.

7858 DETERMINATION OF THE SIGN OF ENANTIOMORPHISM OF PIEZOELECTRIC TEXTURES.
.Shubnikov.
stallografiya (USSR), Vol. 5, No. 4, 644-5 (July-Aug., 1960).
Russian.
It has already been shown that if a square plate is cut from ordinary (right-handed) Rochelle salt so that the ∞ axis is along the vertical diagonal of the square and it is compressed along a direction at 45° to this axis, a negative charge is produced on the face turned towards the observer [see A.V.Shubnikov, I.S.Zheludev, V.P. V.P.Konstantinova and I.M.Sil'verstrova, Investigation of piezoelectric textures (in Russian), Moscow—Leningrad, 1955]. If the Rochelle salt had been left-handed a positive charge would have been produced. Thus it is possible to distinguish right-handed from left-handed forms, if the symmetry is of the type ∞:2, by one piezoelectric experiment. Wood belongs to this symmetry type and piezoelectric experiments were carried out on more than 1100 specimens of wood (oak, ash, beech, etc.): all of them belonging to one enantiomorphic form (arbitrarily called left-handed). [English translation in: Soviet Physics—Crystallography (USA), Vol. 5, No. 4, 615-16 (Jan.-Feb., 1961)]. J.Iball

TRANSMISSION-TYPE PIEZOELECTRICITY DETECTOR. See Abstr. 16218

17859 STUDY OF THE TRIBOELECTRIC PROPERTIES OF VARIOUS SYNTHETIC FABRICS.
G.Goudet and P.Laurenceau.
J. Phys. Radium (France), Vol. 21, Suppl. No. 7, 87A-91A (July, 1960). In French.
A method of measuring charges due to friction caused by knitted synthetic fibres is described, as well as the corresponding apparatus. The method chosen makes it possible to obtain fairly accurate and reproducible results. Two sets of experiments illustrate its application, one examining comparatively the triboelectric properties of knitted polyvinylchloride and acrylonitrile, the other studying the behaviour of knitted polyvinylchloride fibres loaded with CaF_2 in different amounts. Charts indicate how the different knitted materials might be classified, according to their composition.

17860 PLASMA-LIKE SPACE CHARGE EFFECTS AND THEIR DEMONSTRATION BY MEANS OF ELECTRO-OPTIC EFFECTS. K.W.Böer.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 7-8. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].
A résumé of papers published earlier (Abstr. 1664-5 of 1960).

17861 ICE-CRYSTAL CONTACT ELECTRIFICATION. W.C.A.Hutchinson.
Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 406-7 (July, 1960).
An experimental investigation of electrification accompanying the momentary single contact of vapour-grown ice crystals at the same or at different temperatures suggests than any such effect is much smaller than might be expected from Reynolds's report on charging observed with riming spheres and vapour-grown ice crystals.

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

OPTICAL PROPERTIES OF AlP. See Abstr. 17717

17862 MEASUREMENT OF THE OPTICAL CONSTANTS OF BERYLLIUM HYDROXYACETATE FROM THE REFLECTION SPECTRUM BETWEEN 650 AND 900 cm^{-1}. C.Deloupy.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3221-3 (May 24, 1961). In French.
Reflection spectra measurements on a cubic monocrystal of beryllium hydroxyacetate are used to deduce some optical constants which are graphically compared with calculated values.
G.I.W.Llewelyn

COMPARATIVE OPTICAL AND INTERFERROMETRIC STUDIES ON SYNTHETIC DIAMONDS. See Abstr. 14954

17863 CHANGES IN THE OPTICAL PROPERTIES OF THIN IRON FILMS IN VACUUM AND AIR. G.Rasigni.
C.R. Acad. Sci. (France), Vol. 252, No. 24, 3794-6 (June 12, 1961). In French.
Spectroscopically pure Fe was evaporated from a W filament

at a pressure lower than 6×10^{-6} torr onto a quartz substrate. Films of a range of thicknesses were deposited at a fast rate of 2 mμ sec^{-1} and their transmission and reflection factors were measured. They showed little change in a vacuum, but at 10^{-1} torr the thinnest films began to oxidize. Thin films exposed to dry air quickly oxidized and became transparent. Thicker films changed more slowly due to the diffusion of oxygen through the oxide. The bulk behaviour appeared to be reached at an estimated thickness of 30 mμ. W.Steckelmacher

17864 OPTICAL PROPERTIES OF FREE ELECTRONS IN CdS. W.W.Piper and D.T.F.Marple.

J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2237-41 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). The contribution of free electrons to the refractive index and extinction coefficient of Ga-doped CdS was measured in a series of samples with carrier concentrations ranging from about 10^{17} to 2×10^{19} electrons cm^{-3}. The effective mass m* for electrons near the bottom of the conduction band was calculated from the free electron contribution to the refractive index and from the carrier concentration as determined from the Hall coefficient. The result, $m^* = (0.22 \pm 0.01)\, m_e$ is in satisfactory agreement with previous studies by other workers. The magnitude and wavelength variation of the absorption coefficient observed with about 10^{17} carriers cm^{-3} are in fair agreement with theoretical results calculated for a polar-mode lattice scattering mechanism. Although similar data for 2×10^{18} carriers cm^{-3} are in good quantitative agreement with the impurity scattering theory at room temperature, the absorption for high carrier concentration is observed to decrease with temperature, in contradiction with the theory for a nondegenerate population. A theory for the degenerate concentration range is needed. Reflection and transmission of radiation polarized parallel and perpendicular to the crystal C axis were studied for one sample. These data show $(m_\perp^*/m_{||}^*) = 1.08 \pm 0.05$.

17865 OPTICAL PROPERTIES OF LEAD-SALT AND III-V SEMICONDUCTORS. F.Stern.

J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2166-73 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Dispersion relations for optical properties of solids, and a sum rule for the imaginary part of the dielectric constant, are reviewed and applications to semiconductors are described. Plasma frequencies, for which the real part of the dielectric constant vanishes, are associated with lattice vibrations, with free carriers, and with valance electrons. Gottlieb's infrared optical constants for LiF are in good agreement with the lattice vibration sum rule using unit effective charge. Dispersion relations for reflectivity have been used by Dixon to analyse optical constants of p-type PbTe in the infrared region where free-carrier effects dominate. He finds an effective mass at room temperature which rises from 0.1m to 0.3m as the carrier concentration is increased from 3×10^{18} to 10^{20} cm^{-3}. Morrison has measured the reflectivity of InAs, InSb, and GaAs and finds curves which agree well with those of Tauc and Abraham. His analysis of these results using the dispersion relation predicts a plasma energy near 7 eV in these materials. Free carrier absorption in several III-V compounds and in PbS and PbTe is proportional to λ^p at long wavelengths, where p varies between 2, for InSb and AlSb, and 3, for InAs and GaAs. For n- and p-type PbS Riedl has found p = 2.4. He observed additional structure near the intrinsic absorption edge of p-type PbTe, resembling that observed in n-type GaAs and GaP, which may be associated with a valence band about 0.1 eV below the band edge. The absorption coefficient near the absorption edge of all the lead compounds and of InAs is proportional to $e^{\hbar\omega/kT_{eff}}$, with $80^\circ K < T_{eff} < 120^\circ K$ for measurements taken at room temperature. Impurity effects on the energy gap are discussed in terms of a simple model.

REFLEXION COEFFICIENT OF A Cu–Sn ALLOY OBTAINED BY SIMULTANEOUS EVAPORATION OF ITS CONSTITUENTS. See Abstr. 15125

EXTREME ULTRAVIOLET REFLECTANCE OF LiF-COATED ALUMINUM MIRRORS. See Abstr. 16070

17866 DISPERSION MEASUREMENTS OF CsBr IN THE REGION OF ITS INFRARED EIGEN-VIBRATION. R.Geick.

Z. Phys. (Germany), Vol. 163, No. 5, 499-522 (1961). In German.

The infrared transmission and reflection of layers of CsBr were measured at nearly normal incidence in the spectral region 30 to 275 microns. Because of the large changes in the optical constan in this region, the thicknesses used for transmission measureme varied between 0.2 micron and 1.0 cm. The optical constants of CsBr were calculated from the experimental measurements. The dispersion curve of CsBr is similar to those of other alkali halid (LiF, NaCl, etc.), in spite of its somewhat different crystal struc J.N.Hodg

17867 THE TEMPERATURE DEPENDENCE OF THE REFRACTIVE INDEX OF GERMANIUM. F.Lukeš.

Czech. J. Phys., Vol. 10, No. 10, 742-8 (1960).

The temperature dependence of the refractive index of germanium in a wavelength region of 1.8-5.5 μ and temperature region of 100-530°K is given for three samples of single crystal germanium having different concentrations of impurities. The temperature dependence of the refractive index is nonlinear. The results are compared with those of other authors. An attempt is made to theoretically interpret the observed dependence.

17868 MEASUREMENT OF THE REFRACTIVE INDEX OF LUCITE BY RECOILLESS RESONANCE ABSORPTIO L.Grodzins and E.A.Phillips.

Phys. Rev. (USA), Vol. 124, No. 3, 774-6 (Nov. 1, 1961).

A method of frequency-modulating a monochromatic electromagnetic wave by varying the optical path length between the sou and detector is described. The method was applied to the measu ment of the refractive index of Lucite for the 0.86 A radiation emitted from Co^{57}; the small frequency shift was detected by recoilless resonance absorption. The refractive index was found to be $1 - n = (1.29 \pm 0.03) \times 10^{-6}$, in agreement with classical th

17869 STRESS OPTICAL CONSTANTS OF GERMANIUM. K.J.Schmidt-Tiedemann.

J. appl. Phys. (USA), Vol. 32, No. 10, 2058-9 (Oct., 1961).

The two stress optical constants were determined by passing polarized light down an accurately oriented bar of germanium under a tensile stress of up to 200 kg/cm^2. The stress constant an arbitrary direction of stress is calculated, and agreement is obtained within the experimental error. B.R.Hole

17870 EFFECTS OF GAMMA RADIATION ON CERIUM-BEARING PHOSPHATE GLASSES. P.B.Alers.

J. Opt. Soc. Amer., Vol. 51, No. 11, 1251-4 (Nov., 1961).

A series of cerium-bearing phosphate glasses was investiga before and after exposure to gamma radiation in doses of 10^6, 10 and 10^8r. Measurements were made on the magneto-optic (Farad effect) rotations exhibited by the glasses at liquid helium temper tures and in magnetic fields ranging to 70 kG. Absorption curve were also taken before and after exposure and also after annealin No changes in Faraday rotation were observed, indicating that th cerium remained in the cerous state, but the height of a radiation induced absorption peak, located at 3200-3400 A, was found to be inversely proportional to the amount of cerium present. A qualitative explanation of a possible mechanism is presented.

INTERBAND FARADAY ROTATION IN III-V COMPOUNDS. See Abstr. 17740

FARADAY ROTATION IN COMPOUND SEMICONDUCTORS. See Abstr. 17741

17871 MAGNETOREFLECTION EXPERIMENTS IN INTER-METALLICS. G.B.Wright and B.Lax.

J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2113-17 (Oct., 196

"Semiconducting Compounds" Conference Paper, Schenectad 1961 (see Abstr. 14428 of 1961). Magnetoreflection experiments involving both intraband and interband transitions can provide va able information about the electronic band structure of semicond tors. In the intraband experiments, performed near the plasma reflection edge, the application of a magnetic field splits the edge and results in the formation of two minima separated by the cycl tron frequency. It is thus possible to determine the cyclotron frequency directly, at room temperature, and for high carrier concentrations. When scattering losses are taken into account in the theory, it becomes possible to determine the carrier concentration, scattering time, and effective mass from the optical mea ments alone. The theory of the effect is discussed for applied magnetic field transverse and parallel to the direction of propaga tion, and experimental results are presented for InSb, InAs, and HgSe. A consistent fit to Kane's theory for the variation of mass

concentration in InSb is obtained when previously published have been corrected for reststrahl dispersion. Interband etoreflection experiments can be useful in cases where high ption coefficients or difficulty of preparing thin samples make mission experiments unfavourable. This type of experiment s information on energy band gaps, effective masses, and g rs. Experimental data for the direct transition in InSb are nted.

FUNDAMENTAL REFLECTIVITY SPECTRUM OF SEMI-DUCTORS WITH ZINC-BLENDE STRUCTURE.
bstr. 17762

872 OPTICAL PROPERTIES AND PHOTOELECTRON EMISSION OF AMORPHOUS AND CRYSTALLINE FILMS ERMANIUM. P.G.Borzyak and R.D.Fedorovich.
verdogo Tela, Vol. 2, No. 12, 3020-5 (Dec., 1960). In Russian.
Amorphous and crystalline germanium films were prepared her for direct comparison and their reflection and transmission icients measured from 240 to 580 mμ. Exposure to air before urements caused a small quantitative but no qualitative change spectral characteristics. This change occurred in a time less than a minute; no long-term transient effects of this type found. The spectral characteristics of the absorption coeffic- nd refractive index were evaluated and the Kramers–Kronig ion used to determine the correct value of the latter. The ral characteristics of photoelectron emission were measured omparison of the results with the absorption coefficients for 20 and 100 mμ thick films, support the view that photoelectron sion is a surface effect though some anomalies remain.
ish translation in: Soviet Physics - Solid State (USA), Vol. 2, 2, 2683-7 (June, 1961)]. D.J.Huntley

873 ON THE RELATION BETWEEN THE THICKNESS DEPENDENCE OF OPTICAL ABSORPTION AND THE ACE LAYERS OF BARIUM TITANATE SINGLE CRYSTALS.
fová and H.Arend.
. J. Phys., Vol. 10, No. 9, 663-9 (1960).
ingle crystals of $BaTiO_3$, prepared by crystallization in the m $BaCl_2$–BaO–$BaTiO_3$, show a dependence of the optical ption coefficient on the sample thickness. The observed ness dependence of the absorption coefficient can be explained e existence of a surface layer with optical properties differing those of the inner part of the crystal. By means of an etching od a direct determination of the thickness of the surface layer stals in the thickness range of 0.075 to 0.178 mm was carried The value found is $(6.0 \pm 0.2) \times 10^{-4}$ cm.

874 SELECTION RULES FOR ABSORPTION OF LIGHT IN CUBIC CRYSTALS BY QUADRUPOLE EXCITATION.
alishev, V.I.Cherepanov and R.V.Radchenko.
verdogo Tela (USSR), Vol. 3, No. 2, 484-91 (Feb., 1961).
ssian.
The response of the electrons in a cubic crystal to electro- etic radiation is investigated by standard theory. In particular reducible representations of the octahedron-group are used entifying the non-vanishing matrix elements of the electronic upole moment. The results are tabulated. Whereas the dipole tion rules had been found to be independent of the direction of nce and the state of polarization, this is no longer true for upole absorption. Cubic crystals may show a dichroism due to pendence of the absorption on the direction of the plane of ization. This result of the theory is in accordance with observa- on crystals of cuprous oxide. [English translation in: Soviet cs–Solid State (USA), Vol. 3, No. 2, 355-60 (Aug., 1961)].
R.Eisenschitz

PTICAL ABSORPTION EDGE IN GaAs AND ITS DEPENDENCE LECTRIC FIELD. See Abstr. 17729

875 ANISOTROPY OF THE QUADRUPOLE EXCITON ABSORPTION OF LIGHT IN CUBIC CRYSTALS.
herepanov and V.S.Galishev.
verdogo Tela (USSR), Vol. 3, No. 4, 1085-93 (April, 1961).
ssian.
The selection rules for optical exciton transitions in a cubic al with the symmetry group O_h are found. In contrast to a ous work of the authors, where an analogous question was dered on the basis of the hydrogen-like exciton model of ier and Mott, no model is assumed here, and the problem is d by using only general properties of the exciton wave-functions in a cubic crystal following from group-theoretic considerations. It is shown that in cubic crystals under certain conditions two types of quadrupole exciton lines can occur, and, correspondingly, two types of anisotropy and dichroism for the absorption of light. One of these has already been observed by Gross and Kaplyanskii for the first line of the yellow series in cuprous oxide. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 4, 790-5 (Oct., 1961)]. D.J.Thouless

17876 THE QUADRUPOLE ABSORPTION COEFFICIENT AND THE OPTICAL LIFETIME OF THE GROUND STATE OF EXCITONS IN A Cu_2O CRYSTAL. E.F.Gross and A.A.Kaplyanskii.
Dokl. Akad. Nauk SSSR, Vol. 139, No. 1, 75-8 (July 1, 1961).
In Russian.
Investigation of the spatial anisotropy of the absorption of light in Cu_2O is reported, and the results are compared with a theory based on a quadrupole nature for the optical transition on excitation of the ground state of an exciton. The "optical" lifetime is determined from these results and is found to be of the order of 20 sec. [English translation in: Soviet Physics–Doklady (USA)].
K.G.Major

17877 THE INFLUENCE OF Cd ON THE ABSORPTION OF NaCl. J.Kantůrek and K.Suk.
Czech. J. Phys., Vol. 11, No. 8, 579-83 (1961). In Russian.
Absorption measurements on uncoloured and X-rayed crystals of NaCl with different Cd-concentrations were made, to show under what conditions the "non-active" form of this impurity may become the "active" form.

17878 INFRA-RED ABSORPTION DUE TO WATER IN GLASSES. R.V.Adams.
Phys. chem. Glasses (GB), Vol. 2, No. 2, 39-49 (April, 1961).
The infrared absorption by glasses can be divided conveniently into two categories: (a) those absorption bands which can be studied on specimens which are many orders of magnitude thicker than the wavelength of the radiation, and (b) those absorption bands which are so intense that specimens not much thicker than the wavelength of radiation must be used. Category (a) may thus be described conveniently as being concerned with 'thick' specimens (1-2mm) and (b) with 'thin' specimens (1-5μ). This paper reports investigations on thick specimens and concentrates on the absorption bands due to the inclusion of water substance in glasses. A comprehensive review of the literature is first given and is followed by an account of experimental work which is concerned mainly with the substitution for D_2O for H_2O and thus to the positive identification of these absorption bands.

17879 BAND-SPLITTING IN THE SPECTRA OF CUBIC CRYSTALS SUBJECTED TO ORIENTED DEFORMATION.
A.A.Kaplyanskii.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 165-72 (Feb., 1961).
In Russian.
An investigation is made of the amount of splitting of the spectral bands associated with anisotropic centres in cubic crystals subjected to deformation along certain crystallographic directions. It is shown that the amount of splitting is determined by two or three independent parameters which characterize the interaction of the centres with the lattice. The possibility of a similar splitting in the exciton and band state spectra of crystals subjected to oriented deformation is discussed. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 83-7 (Feb., 1961)].

17880 INFLUENCE OF AN ELECTRIC FIELD ON AN OPTICAL BAND EDGE. W.Franz.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (Germany), 1960, No. 1, pp. 10-12. In German. [Colloquium on Inhomogeneous Fields in Solid Dielectrics in the Breakdown Region].
The original paper was published in 1958 (Abstr. 6822 of 1958). This is a very full acount of the paper which deals with the theory of the shift of the fundamental absorption edge with field. A comparison with experimental results on CdS is made. K.W.Plessner

17881 A MAGNETO-STARK EFFECT AND EXCITON MOTION IN CdS. D.G.Thomas and J.J.Hopfield.
Phys. Rev. (USA), Vol. 124, No. 3, 657-65 (Nov. 1, 1961).
Exciton absorption occurs, for weak exciton lines, at an energy which is the energy of an exciton having a wave vector equal to that of the light in the medium. These excitons have a finite wave vector, and therefore, a finite velocity. In a uniform magnetic field, the Lorentz force on the electron and hole due to the centre-of-mass

velocity produces a magnetic perturbation in addition to those ordinarily considered. The measurement of such a perturbation measures the velocity of an exciton of known wave vector, and therefore determines the total exciton mass. In addition, the measurement of this effect which depends on the exciton velocity provides a positive distinction between exciton absorption lines and absorption lines due to impurities. It is shown that this perturbation can be measured by the measurement of the Stark effect on excitons in the presence of a uniform magnetic field. The exciton mass for the n = 2 states of excitons formed from the top valence band in CdS was measured by this technique, and found to be 0.92 ± 0.18, in reasonable agreement with the mass calculated from independent experiments. The Stark effect in the absence of a magnetic field was also studied to ensure an understanding of the effect in the presence of a magnetic field. The Stark effect in a magnetic field sometimes exhibits peculiar behaviour which was attributed to an extraneous Hall field. This interpretation gives an estimate of $\omega_c\tau_r \cong 2$ for electrons in "good" CdS crystals at 1.6°K and at 31 000 G.

17882 OPTICAL ABSORPTION OF POLYCRYSTALLINE LAYERS OF CdS.
K.V.Shalimova, T.S.Travina and L.L.Golik.
Dokl. Akad. Nauk SSSR, Vol. 138, No. 1, 90-2 (May 1, 1961). In Russian.

For abstract, see Abstr. 14588 of 1961. [English translation in: Soviet Physics – Doklady (USA), Vol. 6, No. 5, 396-8 (Oct., 1961)].

17883 ANALYSIS OF POLARIZED CRYSTAL SPECTRA. THE SPECTRUM OF COBALT (III) ACETYLACETONATE. T.S.Piper.
J. chem. Phys. (USA), Vol. 35, No. 4, 1240-2 (Oct., 1961).

The analysis of the broad bands in the polarized electronic spectra of transition metal ions in crystals is discussed. The band of cobalt (III) acetylacetonate due to the transition $^1T_1 \rightarrow {}^1A_1$ is found to be split by the trigonal field into components at 16 200 cm^{-1} ($^1A_2$) and at 17 000 cm^{-1} (^1E) The spectra indicate that the trigonal field of the free molecule is not appreciably distorted in the monoclinic crystal.

17884 BAND STRUCTURE OF CUPROUS OXIDE.
A.G.Zhilich and V.P.Makarov.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 585-7 (Feb., 1961). In Russian.

The Kohn–Rostoker method (Abstr. 7602 of 1954) is applied to an ionic model with two O^{2-} and four Cu^+ ions in the elementary cell. The energies $\epsilon(\Gamma_1)$ and $\epsilon(\Gamma'_{25})$ for k = 0 are calculated to be 0.888 and 0.712 Ry respectively, the difference 0.176 Ry = 2.38 eV agreeing well with the experimental value for the limiting frequency of the "green" exciton series. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2, 429-30 (Aug., 1961)].

R.Berman

17885 INVESTIGATION OF THE EXCITON STARK EFFECT IN ORIENTED SINGLE CRYSTALS OF CUPROUS OXIDE. E.F.Gross, B.P.Zakharchenya and L.M.Kanskaya.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 972-8 (March, 1961). In Russian.

The effect of electric fields on excitons in Cu_2O was investigated at 4.2°K using a grating spectrograph. The frequency shift of the lines of the fundamental series of excitons, and also subsidiary lines was examined. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 3, 706-11 (Sept., 1961)].

K.N.R.Taylor

17886 ABSORPTION SPECTRUM OF γ-IRRADIATED LEAD SILICATE GLASS.
R.S.Barker, T.K.Harrison, D.A.Richardson and R.Rimmer.
Nature (GB), Vol. 191, 374 (July 22, 1961).

The results of a previously reported experiment (Abstr. 16074 of 1960) are re-analysed. The full spectral absorption curve can be represented by the sum of two bands, at 2.54 eV and 3.36 eV.

D.G.Holloway

17887 OPTICAL ABSORPTION SPECTRA OF Ni-DOPED OXIDE SYSTEMS. I.
R.Pappalardo, D.L.Wood and R.C.Linares, Jr.
J. chem. Phys. (USA), Vol. 35, No. 4, 1460-78 (Oct., 1961).

The optical absorption was studied at room temperature, at 78°, and at 4.2° in the 2.6 μ to 0.2 μ region in single crystals of MgO, ZnO, $MgAl_2O_4$, and yttrium-gallium garnet doped with nickel. The absorptions found were correlated to electronic transitions within t 3d-shell using the formalism of the crystal-field theory. The value of the Dq and B parameters were derived for MgO:Ni (Dq = – 815 cm^{-1}; B = 890 cm^{-1}) and for ZnO:Ni where Ni is tetr hedrally coordinated (Dq = 405 cm^{-1}; B = 795 cm^{-1}). Interesting fine structure was found in the absorption spectra of MgO:Ni and implications are discussed. At attempt is made to explain some the fine structure of the absorptions in MgO and ZnO as due to spin-orbit effects. The observed spectra for MgO:Ni are used to infer the presence of Ni^{++} in octahedral coordination, both in the spinel and in the green phase of yttrium gallium garnet.

17888 EFFECT OF PRESSURE ON CRYSTAL-FIELD ENER AND COVALENCY IN OCTAHEDRAL COMPLEXES O Ni^{2+}, Co^{2+}, AND Mn^{2+}. J.C.Zahner and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 1, 1483-90 (Oct., 1961).

The effect of pressure was measured on the absorption spect of $NiCl_2$, $NiBr_2$, $Ni(NH_3)_6Cl_2$, $CoCl_2$, $CoBr_2$, $MnCl_2$, and $MnBr_2$. T pressure shifts in every case correspond to increase in crystal field strength. To account for the shifts in a quantitative manner is necessary to presume that the Racah parameter B decreases with increasing pressure. This can be interpreted as an increas covalency at high pressure. From the data on $MnCl_2$ and $MnBr_2$ is possible to establish limitations on the possible range of value of the parameter ϵ introduced by Koide and Pryce to decribe covalency in transition metal complexes.

17889 EFFECT OF PRESSURE ON THE LOW-ENERGY ABSORPTION PEAK OF SEVERAL PHTHALOCYANINES. B.M.Riggleman and H.G.Drickamer.
J. chem. Phys. (USA), Vol. 35, No. 4, 1343-4 (Oct., 1961).

The effect was measured in nine phthalocyanines in the solid state. In all cases the peak shifted to lower energies. The shift were not large, but were very sensitive to the metal ion in the phthalocyanine. In general, the amount of shift was greater for ions having larger polarizability. The shift is attributed to perturbation of the excited π electron state due to dispersion inte action with metal ions in adjacent molecules.

17890 SOME OPTICAL PROPERTIES OF LEAD ACTIVATE POTASSIUM HALIDE PHOSPHORS. Y.Kaifu.
J. Phys. Soc. Japan, Vol. 16, No. 8, 1605-16 (Aug., 1961).

Absorption, emission and excitation spectra of KCl:Pb and KBr:Pb were measured at various temperatures. These observe spectra are similar to those of KCl:Tl, and the absorption bands seemed to be due to transitions in Pb^{++} ions which occupies the normal positive ion sites. The two principal excited states are ^{1} and $^3P_1$ of Pb^{++} ion. 273 mμ absorption, 345 mμ emission in KC and 302 mμ absorption, 365 mμ emission in KBr:Pb are attribute to $^3P_1 \rightarrow {}^1S_0$ transitions perturbed by surrounding host lattice ions. The excitation to the $^1P_1$ state does not manifest any distinct emission which is different from the case of Tl activated phosph The near u.v. emission suffers violent thermal quenching at roo temperature, and the activation energies of these nonradiative pr cesses are found to be 0.28 eV and 0.18 eV for KCl:Pb and KBr: respectively. Discusses a single configuration coordinate model

17891 ANALYSIS OF THE SPECTRA OF TRIVALENT PROMETHIUM AND HOLMIUM.
M.H.Crozier and W.A.Runciman.
J. chem. Phys. (USA), Vol. 35, No. 4, 1392-1407 (Oct., 1961).

The spin–orbit matrices for the f^4 configuration were calculated and checked. They were applied to the analysis of the solid-state spectra of trivalent promethium and holmium. A tentative energy-level scheme for promethium is obtained. In th case of holmium, all levels below 27 000 cm^{-1} have been identifi including two levels hitherto unreported in the solid state, at 25 900 cm^{-1} and 26 190 cm^{-1}, and a root mean-square deviation between calculated and observed energies of 96 cm^{-1} is achieved Values of the Lande splitting factor g are predicted for the holmium levels.

SPECTRA AND ENERGY TRANSFER PHENOMENA IN CRYSTALLINE RARE GAS SOLVENTS. See Abstr. 17313

PRESSURE DEPENDENCE OF THE DIRECT ENERGY GAP IN GERMANIUM. See Abstr. 17447

THE ABSORPTION SPECTRA OF MAGNESIUM AND MANGANESE ATOMS IN SOLID RARE GAS MATRICES. See Abstr. 17269

7892 SPECTROSCOPIC RESEARCH ON SILVER IODIDE AND LEAD IODIDE IN THE CRYSTALLINE STATE.

rny.
Phys. (France), Vol. 5, No. 11-12, 1683-1740 (Nov.-Dec., 1960).
rench.

Measurements of absorption, reflection, and photoluminescence e intrinsic region were made on thin films of AgI and PbI_2. The s were prepared by evaporation of the metal in the presence of ie vapour. Other preparation techniques are detailed. At tem- tures below 20°K exciton bands are observed in both substances. photoluminescence results indicate total recombination of holes electrons in the valence band (annihilation of excitons) and radi- e transitions between polarized exciton levels and a fundamental l in the valence band. Transitions at k = 1 are observed in the oluminescent spectra. Three AgI polymorphs: α (cubic), ubic), and γ (hexagonal) were identified, and their behaviour ied as a function of temperature and annealing treatment. In the of PbI_2 (hexagonal) the method of sample preparation has a ng influence on the spectra. Films made by sublimation do not the exciton levels. D.L.Greenaway

7893 OPTICAL ABSORPTION OF SOME OXIDES IN THE SCHUMANN ULTRA-VIOLET REGION. W.P.Doyle.
. J. appl. Phys., Vol. 12, No. 10, 574-6 (Oct., 1961).

The optical absorption of thin films of stannous oxide, stannic e, lead monoxide, the trioxides of arsenic, antimony and bis- n, beryllium oxide, zirconium dioxide and tantalum pentoxide measured in the energy range 4 to 10.5 eV.

7894 SPECTROSCOPY AT EXTREME INFRARED WAVE-LENGTHS. II. THE LATTICE RESONANCES OF IONIC STALS. G.O.Jones, D.H.Martin, P.A.Mawer and C.H.Perry.
c. Roy. Soc. A (GB), Vol. 261, 10-27 (April 11, 1961).

For Pt I see Abstr. 16077 of 1961. Sixteen crystalline c halides were studied in transmission and reflection riments in the range 70 to 250 μ at temperatures down to . The lattice resonances were clearly observed, their acteristic frequencies accurately determined and the degree of ping investigated as a function of temperature. The significance ie results is discussed from the point of view of various models ielectric behaviour — in particular the refinements of the n–Lorentz model which cover the effect of distortion moments to the overlap of neighbouring ions. Discrepancies remain een theory and experiment which have a bearing on the calcula- of vibration spectra.

7895 ABSORPTION BANDS ARISING FROM THE ION SO_4^{2-} IN $CuSO_4.5H_2O$ AND IN $CuSO_4.H_2O$. L.Gamo.
R. Acad. Sci. (France), Vol. 252, No. 16, 2402-3 (April 17, 1961).
rench.

The measured absorption bands for the two crystals in the ge 950 to 1200 cm^{-1} are interpreted in terms of their molecular ctures given by X-ray analysis. E.A.Mussett

7896 THE INFRARED ABSORPTION SPECTRA OF THE HARMONICS AND COMBINATIONS OF INTERNAL RATIONS OF CALCITE, DOLOMITE, AND MAGNESITE BETWEEN 0 AND 7000 cm^{-1}. J.Andre-Louisfert.
. Acad. Sci. (France), Vol. 252, No. 23, 3565-7 (June 5, 1961).
rench.

The spectra are interpreted by assuming that Fermi-type onances take place between the degenerate valence frequency and the combination $Eg_2 + Eu_2$, and that these frequencies are e to that of Eg_1. It is shown that for corresponding bands the bination frequency of dolomite is the arithmetic mean between combination frequencies of calcite and magnesite.
D.L.Greenaway

17897 STUDY OF THE CHROMIUM (III) SULPHATES BY THERMOGRAVIMETRY AND INFRARED ABSORPTION. Harmelin.
R. Acad. Sci. (France), Vol. 252, No. 26, 4142-4 (June 26, 1961).
rench.

Chromic sulphate forms a series of hydrates $Cr_2(SO_4)_3.nH_2O$ re $n \leq 18$. The value of n depends strongly on the mode of stallization. The behaviour of the hydrates with increasing perature was studied using a thermobalance; spectra were ob- ed in the 300-5000 cm^{-1} region. The violet form (n = 14) has water molecules bonded directly to the sulphate radicals, and nt (two of which can form hydrogen bridges) grouped around the chromium atoms. D.L.Greenaway

17898 LATTICE ABSORPTION IN GALLIUM ARSENIDE. W.Cochran, S.J.Fray, F.A.Johnson, J.E.Quarrington and N.Williams.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2102-6 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). A series of detailed measurements of the lattice absorption bands of gallium arsenide was made over the wavelength range 10-40 μ and over the temperature range 20°-292°K. These results can be interpreted in terms of multiple phonon interactions involving five characteristic phonon energies. These results, along with known elastic constants, enabled all the relevant data for a computation of the complete phonon spectrum, using an extension of the shell model, to be supplied.

17899 A CONTRIBUTION TO THE STUDY OF INFRARED EMISSION IN GERMANIUM. J.I.Pankove.
Ann. Phys. (France), Vol. 6, No. 3-4, 331-74 (March-April, 1961).
In French.

A study was made of the infrared emission due to the radiative transition of holes between two branches of the valence band in germanium. The Suhl effect was used to distinguish surface emission from volume emission and a light-scanning technique was used to determine the emission region. Further, an extensive study was made of the optical properties of very impure germanium.
A.J.Fox

17900 OSCILLATORY MAGNETOABSORPTION IN InSb UNDER HIGH RESOLUTION.
S.Zwerdling, W.H.Kleiner and J.P.Theriault.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2118-23 (Oct., 1961).
"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Polarized oscillatory magneto-absorption spectra of exciton formation transitons in InSb were measured under high resolution at liquid helium temperature. An unstrained high-mobility sample 5 μ thick and magnetic fields up to 39.1 kG were used. Diffraction grating dispersion for the region $3.7 < \lambda < 6.0\mu$ made possible a resolution of $1\text{-}7 \times 10^{-4}$ eV and the determination of absorption maxima to $\pm 5 \times 10^{-6}$ eV. Sixteen minima were resolved with $\vec{E} \perp \vec{B}$ for a field of only 5.0 kG. The initial interpretation of the detailed spectra obtained involved fitting theoretical spectra calculated from the theories of Kane, Luttinger, and Elliott-Loudon in order to account for band nonparabolicities, valence band degeneracy effects, and exciton binding energies, respectively. The results experimentally established the light-hole nonparabolicity, the valence band degeneracy effects for low magnetic quantum numbers, and the existence of high-field excitons in InSb.

17901 INFRARED SPECTRA OF FATTY ACIDS IN THE SOLID STATE IN THE REGION 700-900 cm^{-1}.
R.Perron and J.Périchon.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3224-6 (May 24, 1961).
In French.

The effect of the carboxyl group on the infrared rotation bands of the hydrocarbon chain has been studied for the fatty acids from C_8 to C_{22}. G.I.W.Llewelyn

17902 ORIGINS OF CHARACTERISTIC BANDS IN THE INFRARED SPECTRA OF ISOTACTIC POLYSTYRENE AND ISOTACTIC POLY (RING-d_5 STYRENE).
T.Onishi and S.Krimm.
J. appl. Phys. (USA), Vol. 32, No. 11, 2320-5 (Nov., 1961).

The origins of characteristic bands in the infrared spectrum of isotactic polystyrene were studied with the aid of the spectrum of isotactic poly-(ring-d_5 styrene). It is found that these bands can be classified into three types according to their experimental behaviour upon crystallization of the specimen. Assignments show that the bands in any one group are associated with a specific kind of normal vibration, either of the chain or of the benzene ring. Analysis of one of these band types indicates that rotational disordering of the benzene rings may occur, and that crystallization of the polymer is probably correlated with the growth of regions which maintain statistical variability at the local chain level.

OPTICAL PROPERTIES OF SnS CRYSTALS. See Abstr. 17760

LOW-FREQUENCY INFRARED ABSORPTION SPECTRUM OF THE HYDROGEN BOND IN CRYSTAL HYDRATES. See Abstr. 15882

17903 THE SECOND-ORDER RAMAN EFFECT AT LOW TEMPERATURES.
A.I.Stekhanov, Z.A.Gabrichidze and M.B.Eliashberg.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1331-4 (May, 1961).
In Russian.

The effect was investigated at 77 and 300°K. In the case of KI crystals the spectrum obtained looks like a continuous spectrum, this appearance persisting at low temperatures. The results indicate that the elastic spectra of alkali halide crystals are quasi-continuous. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 5, 964-6 (Nov., 1961)]. F.Lachman

17904 THE INFLUENCE OF GALLIUM ADMIXTURE ON THE POSITION OF $L\alpha_{1,2}$ AND $L\beta_6$ EMISSION LINES OF GERMANIUM. M.I.Korsunskii, L.B.Litvinova and G.P.Borovikova.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 1, 282-5 (Jan., 1961).
In Russian.

The X-ray spectrum of p-type germanium was investigated and compared with that of n-type. The energy differences between the two germanium lines $L\alpha_{1,2}$ and $L\beta_6$ decreased when a small amount of gallium was added to the crystal. The same shift of the line $L\beta_6$, but in the opposite direction, was noticed when some antimony was added to germanium. It was shown that the energy difference between the two lines varies proportionally to the cubic root of the concentration of the admixture. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 1, 205-7 (July, 1961)].
W.G.Jordan

17905 K ABSORPTION SPECTRA OF ZIRCONIUM, ITS OXIDE AND OXYCHLORIDE. A.Ganson.
J. Phys. Radium (France), Vol. 22, No. 5, 298-302 (May, 1961).
In French.

Results of an investigation of the X-ray absorption spectra of zirconium, hydrated and anhydrous ZrO_2 and $ZrOCl_2$ as well as of solutions of $ZrOCl_2$ are given as a function of the thickness of the absorbing layer (or concentration of the solution). The spectra were obtained using a Cauchois spectrograph with a bent mica crystal, by transmission. The K absorption edge of metallic Zr is shown to fall in two steps, and an explanation is suggested.

A STUDY OF THE QUANTUM EFFICIENCY OF X-RAY RADIATION ABSORBED IN A P–N JUNCTION. See Abstr. 17679

Luminescence

17906 RELATIONSHIP OF THE LUMINESCENT EDGE TO THE STRUCTURE OF THE FUNDAMENTAL ABSORPTION EDGE. E.F.Gross and R.I.Shekhmamet'ev.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 3, 889-94 (March, 1961).
In Russian.

A review of previous work on many substances is given, with numerous references. Observations were made on both the yellow and red modifications of HgI_2, and a correlation was found between the absorption and luminescent edges. It is concluded that exciton states play a role in the luminescence phenomena. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 3, 647-50 (Sept., 1961)]. K.N.R.Taylor

17907 SOME SPECIAL CASES OF LUMINESCENCE KINETICS. V.V.Antonov-Romanovskii.
Optika i Spektrosk.(USSR), Vol. 10, No. 2, 214-19 (Feb., 1961).
In Russian.

The case considered is that of decay when two kinds of traps which differ slightly in depth are present. It is shown that the quadratic dependence of the steady-state photoconductivity on the intensity of the exciting light can be explained within the framework of the conventional zone model of a phosphor. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 107-10 (Feb., 1961)].

17908 QUANTUM EFFICIENCIES OF SOME INORGANIC PHOSPHORS. P.D.Johnson.
J. Opt. Soc. Amer., Vol. 51, No. 11, 1235-8 (Nov., 1961).

Absolute quantum efficiencies of several inorganic phosphors were measured with excitation in the spectral region 1500 to 2900 A. In contrast to the results of Butaeva and Fabrikant no efficiencies greater than unity were found. The measurements were made comparing excitation spectra with absolute quantum efficiency determinations under excitation by 2537 A mercury resonance radiation. A method for determining quantum efficiencies using only relative radiance measurements on a series of phosphors having different activator concentrations, was used to confirm results obtained with vacuum ultraviolet excitation.

17909 PHYSICAL PROCESSES IN ALKALI HALIDE CRYSTAL PHOSPHORS; ACTIVATED BY MERCURY-LIKE IONS
Ch.B.Lushchik, G.G.Liid'ya, N.E.Lushchik, K.K.Shvarts and I.V.Yaék.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 4, 1176-84 (April, 1961).
In Russian.

Reviews the work by the group at Tartu, which shows that Seitz theory is essentially correct. The processes studied are ionic, dislocation, electron–phonon, electron–hole, exciton and sensitized luminescence in NaCl, KCl, KBr and KI, activated by Ga^+, Ge^{++}, In^+, Sn^{++}, Tl^+ and Pb^{++}. It is shown that the alkali halide crystal lattice plays an important role in the transfer and accumulation of excitation energy, and the phenomena are complicated by the processes of migration of energy between the impurity centres and between these centres and the ions of the basic crystal. [English translation in: Soviet Physics—Solid State (USA), Vol. 3, No. 4, 855-60 (Oct., 1961)]. R.Bell

17910 TWO-PHOTON EXCITATION IN $CaF_2:Eu^{2+}$.
W.Kaiser and C.G.B.Garrett.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 229-31 (Sept. 15, 1961).

Excitation of a 1 mm-thick crystal of CaF_2 containing 0.1% Eu^{2+} by the 6943 A light from a ruby optical maser (Abstr. 21007 of 1960) produces a blue emission band with peak 4250 A. This does not occur if Eu is absent. The intensity of the blue emission is proportional to the square of that of the incident red light, the latter varying over a range of ~ 50-fold, which indicates the excitation of the Eu^{2+} ion by two photons of red light. Fluorescent decay then gives the blue emission characteristic of Eu^{2+}. Calculations show the efficiency of the process to be ~ 10^{-3}, and agree with the amount of blue light observed for each 500 μsec flash from the maser. S.T.Henderson

17911 EMISSION SPECTRA OF POTASSIUM BROMIDE–THALLIUM PHOSPHORS. T.Tamai and E.Matsui.
J. Phys. Soc. Japan, Vol. 16, No. 7, 1489 (July, 1961).

The same emission results from excitation in any of the three bands. At room temperature the emission is a broad band centered on 3500 A, which is resolved at liquid-nitrogen temperature into bands at 3170 and 3650 A. S.T.Henderson

17912 EDGE EMISSION IN ZINC SELENIDE SINGLE CRYSTALS.
D.C.Reynolds, L.S.Pedrotti and O.W.Larson.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2250-4 (Oct., 1961).

"Semiconducting Compounds" Conference Paper, Schenectady, 1961 (see Abstr. 14428 of 1961). Edge emission in single crystals of ZnSe subjected to ultraviolet radiation at low temperatures was examined in the temperature interval from 4.2° to 77°K. Two distinct edge emission spectra were found indicating that two different types of single crystals exist. For type I crystals the edge emission spectrum at 4.2°K contains 10 lines located between 4400 A and 4800 A; at 77°K the emission spectrum contains two lines. For type II crystals the edge emission spectrum at 4.2°K contains 14 lines located between 4400 A and 4900 A; at 77°K the emission spectrum contains three lines, one of which is located at the fundamental absorption edge of the crystal. Both crystal emissions show evidence of phonon interaction with the ZnSe lattice and both emissions undergo significant reductions in intensity as the crystal temperature increases from 4.2° to 77°

17913 THE LUMINESCENCE PROPERTIES OF GOLD-ACTIVATED ZINC SELENIDE.
L.Ya.Markovskii and R.I.Smirnova.
Optika i Spektrosk. (USSR), Vol. 10, No. 2, 194-7 (Feb., 1961).
In Russian.

A description is given of certain luminescence properties of gold-activated zinc selenide under photoexcitation and cathode excitation. [English translation in: Optics and Spectrosc. (USA), Vol. 10, No. 2, 98-9 (Feb., 1961)].

17914 REVERSIBLE TRANSFORMATIONS OF LUMINESCENCE CENTRES IN ZnS PHOSPHORS.
licks, N.Riehl and R.Sizmann.
Phys. (Germany), Vol. 163, No. 5, 594-603 (1961). In German.
The centre responsible for green luminescence in ZnS:Cu is at a lattice site, whilst association with another (interstitial) ion produces blue luminescence. The latter Cu^+ may diffuse y with temperature rise (up to about 300°C), giving a lower blue: en ratio in the emission. By experiments on a phosphor in a led tube it is shown that this action is reversible with a dissoci- n energy of 0.38 eV. The addition of NH_4Cl alters the blue:green o. If the interstitial Cu^+ is completely removed and charge com- sation effected by Zn^{2+} diffusing in, the change towards green by ting is not reversible, as when thin phosphor layers are used in cuated vessels. S.T.Henderson

17915 ROLE OF THE STIMULATING ACTION OF EXCITING LIGHT IN THE KINETICS OF LUMINESCENCE OF :Cu CRYSTALLINE PHOSPHORS. L.A.Vinokurov and M.V.Fok.
ika i Spektrosk. (USSR), Vol. 10, No. 2, 225-31 (Feb., 1961).
tussian.
It is shown that when exciting light frees electrons from traps he ZnS:Cu phosphor, this results in a decrease of electron centration in deep traps as the intensity of excitation increases. er the excitation stops, the distribution of electrons among traps dually approaches the equilibrium value. The flash produced by ared radiation is determined mainly by the freeing of electrons n deep levels. The indicated effects can therefore be found by asuring the magnitude of this flash for different afterglow nsities and at different decay stages. [English translation in: ics and Spectrosc. (USA), Vol. 10, No. 2, 112-15 (Feb., 1961)].

916 POLARIZATION OF PHOSPHORESCENCE IN ORGANO-PHOSPHORS. V.A.Pilipovich.
ika i Spektrosk.(USSR), Vol. 10, No. 2, 209-13 (Feb., 1961).
Russian.
The anisotropy of the afterglow and total luminescence of anophosphors is studied. A variation in the degree of polariza- of β-phosphorescence in the emission spectrum was found for the compounds investigated. The results are discussed from viewpoint of the hypothesis of the complex structure of a astable state. [English translation in: Optics and Spectrosc. A), Vol. 10, No. 2, 104-7 (Feb., 1961)].

7917 FINE STRUCTURE OF THE LUMINESCENT SPECTRA OF ORGANIC MOLECULES IN CRYSTALLINE LUTIONS. A.Ciais.
Chim. phys. (France), Vol. 58, No. 2, 190-203 (Feb., 1961).
French.
Measurements have been made of the luminescence spectra of utions of benzene, napthalene, deuterated napthalene, anthracene, racene, phenanthrene, pyrene, fluorene, acenapthene and terated acenapthene in solid pentane at 4°K, 20°K and 77°K. h transition has been found to be made up of several strong s, whose number depends upon the nature of the solvent and he solute and also on the concentration and temperature of the ution. These strong lines are accompanied by a larger number eak lines. Each spectrum may be divided into a number of tems (3 to 5) within which the interval between two weak lines n integral multiple of a basic unit. This unit was found to be he for fluorescent and phosphorescent emission. The structure y be explained by representing the molecules by rotators ated in lattice vacancies of the solvent, and which are affected he periodic field of the surrounding solvent molecules. If the centration of the solute is sufficiently low, no quenching of the ational motion occurs due to interactions between neighbouring ute molecules. The results of this work have been summarized previous article. [Cryogenics (GB), Vol. 1, 53 (1960)].
P.J.Dean

7918 TEMPERATURE DEPENDENCE OF SCINTILLATION PULSES IN ANTHRACENE AND CsI(Tl).
omma and S.Takemoto.
. sci. Instrum. (USA), Vol. 32, No. 9, 1055-6 (Sept., 1961).
Investigated for anthracene over the temperature range −269° 0°C and for CsI(Tl) over the range −130° to 20°C, using polonium ha-particles as a source of excitation. It was found that: (1) The se height of anthracene varies linearly with temperature over the range investigated; the temperature coefficient was found to be −0.61 ± 0.04% change in pulse height/°C. (2) The temperature coefficient of CsI(Tl) is a nonlinear function of temperature, the pulse height between −50° and 20°C being constant. It was also found that the resolution of the alpha-particle peak increased as the temperature decreased. The results obtained are compared with those of other workers. C.F.Barnaby

17919 INFRA-RED EMISSION AND ELECTROLUMINESCENCE IN ZINC SULPHIDE PHOSPHORS. D.W.G.Ballentyne.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 348-53 (Sept., 1961).
It is shown that the infrared emission of ZnS phosphors is dependent upon the copper concentration. Infrared emission occurs after simultaneous excitation by ultraviolet and infrared in phosphors containing less than 5×10^{-4} g atoms Cu per mole ZnS. For greater concentrations of copper, infrared emission does not occur but such phosphors are electroluminescent.

17920 THE ELECTROLUMINESCENCE OF ZnS:Cu SINGLE CRYSTALS EXCITED WITH PULSES OF ALTERNATING POLARITY. K.Pátek.
Czech. J. Phys., Vol. 10, No. 6, 452-67 (1960).
The brightness waves of electroluminescence of ZnS:Cu were measured for the case of excitation with rectangular pulses as a function of the amplitude of the pulses and the temperature. A concrete model is proposed for electronic processes in barriers in ZnS crystals, the consequences of which for the decay of electro-luminescence are in agreement with measurements.

17921 THE INFLUENCE OF A SMALL ELECTRIC PERTURBATION ON THE ELECTROLUMINESCENCE CURVE OF ZnS:Cu. K.Pátek.
Czech. J. Phys., Vol. 10, No. 9, 679-83 (1960).
The influence of a small electric perturbation of variable phase on the brightness wave of alternating electroluminescence of ZnS:Cu is investigated. The results are compared with the model described in the preceding abstract. The increase in the number of ionized activators after switching on the electric field is studied and is found to reach equilibrium after about 50 to 150 μsec.

17922 ON THE ELECTROLUMINESCENCE OF ZnS AT LOW VOLTAGES. K.Pátek.
Czech. J. Phys., Vol. 11, No. 1, 18-20 (1961).
The possibility of explaining non-zero electroluminescence brightness below the minimum ionization voltage by the influence of thermal velocities of electrons is pointed out; the derived voltage dependence of electroluminescence brightness agrees with the measurements of Thornton (Abstr. 9492 of 1959).

17923 THE ELECTROLUMINESCENCE OF ZnS:Cu, Mn. S.Damašková and K.Pátek.
Czech. J. Phys., Vol. 11, No. 5, 336-43 (1961).
The brightness waves of ZnS:Cu, Mn phosphor were investigated and it was found that their shape changes from that characteristic for copper-activated phosphors to that characteristic for manganese-activated phosphors as a function of the magnitude of the voltage applied, the length of the pulses and the temperature. In order to explain the results it is assumed that simultaneously with the mechanism of electroluminescence accepted for ZnS:Cu (ionization of activators; recombination and radiation delayed in phase compared with voltage), there exists an immediate recombination of the Cu activators in the barriers, which is accompanied by radiation in phase with the voltage.

17924 PHOTOLUMINESCENT EFFECTS IN CONTACT ELECTROLUMINESCENCE. B.Morosin and F.A.Haak.
J. Electrochem. Soc. (USA), Vol. 108, No. 5, 477-8 (May, 1961).
Mixtures of photoluminescent phosphors with metal particles or powdered materials of high dielectric constant, observed in castor oil cells under a.c. fields, may give emission which is not intrinsic electroluminescence but photoluminescence. It appears to depend on the intermediate production of ultraviolet or violet light, possibly by local glow discharges. S.T.Henderson

17925 THE EFFECT OF ANNEALING ON THERMOSTIMULATED PROCESSES OF COLOURED SODIUM CHLORIDE CRYSTALS. A.Bohun.
Czech. J. Phys., Vol. 10, No. 5, 360-5 (1960).

It is shown experimentally that after annealing samples of NaCl the thermoluminescence in the high-temperature maxima not only increases, which is in agreement with the results of other authors, but that simultaneously the thermoemission decreases. It follows from a discussion of the results that this effect is probably caused by the formation of a surface layer, which takes place during the evaporation of the sodium, and prevents the emission of the electrons from the crystal; the vacancies left in it by the sodium increase the concentration of the V centres and thus the probability of luminescence.

17926 EFFECTS OF PHOSPHOR POWDER DISPERSION IN ELECTROLUMINESCENT LAMPS. W.A.Thornton.
J. appl. Phys. (USA), Vol. 32, No. 11, 2379-85 (Nov., 1961).

The statistical distribution of phosphor crystals in the solid dielectric material of a practical electroluminescent lamp influences its observed characteristics. Calculation on the basis of a very simple model shows that maximum efficiency is favoured by high phosphor concentration, fine particles, and thick phosphor layers; the slope and intercept of the usual brightness–voltage plots are affected by the same variables. Measurements on electroluminescent lamps with these variations are in substantial agreement with prediction.

MAGNETIC PROPERTIES OF SOLIDS

17927 LOCALIZED MOMENTS IN METALS. P.A.Wolff.
Phys. Rev. (USA), Vol. 124, No. 4, 1030-5 (Nov. 15, 1961).

A simple model is used to study the occurrence of localized magnetic moments in dilute alloys. The phenomenon is treated as a scattering problem in which conduction electrons scatter from impurity potentials. Under appropriate circumstances the scattering amplitude may show a resonance — corresponding to a virtual level of the impurity. It is shown that if such a level is sufficiently sharp and lies close enough to the Fermi level, the impurity atom will develop an exchange potential that polarizes neighbouring electrons. The potentials for spin-up and spin-down electrons are determined by a pair of coupled equations, whose solutions are discussed in a number of interesting cases.

17928 THE CALCULATION OF THE AFTER-EFFECT FUNCTION OF A SYSTEM OF INTERACTING PARTICLES. L.Ya.Kobelev.
Fiz. Metallov i Metallovedenie (USSR), Vol. 10, No. 2, 306-8 (Aug., 1960). In Russian.

The after-effect function associated with the magnetic susceptibility of a system is derived. Its first term coincides with the after-effect function obtained in previous work, the other terms are corrections due to interaction. F.Herbut

17929 MAGNETIC SUSCEPTIBILITY OF MERCURIC OXIDE AT VARIOUS TEMPERATURES.
H.Mikhail, Z.Hanafy and T.M.Salem.
J. chem. Phys. (USA), Vol. 35, No. 4, 1185-8 (Oct., 1961).

Mercuric oxide exists in two forms, the red and the yellow oxides. Magnetic susceptibility determinations showed no appreciable difference between the two oxides; the red one has a mass susceptibility of $(-0.221_7 \pm 0.0002) \times 10^{-6}$ e.m.u./g while the yellow one has a slightly lower mass susceptibility of $(-0.216_5 \pm 0.0002) \times 10^{-6}$ e.m.u./g at room temperature (25°C). The temperature variation of their mass susceptibility between room temperature (25°C) and about 300°C was also investigated. The general shape of the curve for the two oxides is essentially the same, namely, an increase in diamagnetism with rise in temperature followed by a mild drop and subsequently a sharp rise. The position of the peak occurs at about 50°C for the red oxide and at about 114°C for the yellow oxide. A tentative explanation of their behaviour was given, based on impurity ionization.

17930 DE HAAS–VAN ALPHEN EFFECT IN p-TYPE PbT AND n-TYPE PbS.
P.J.Stiles, E.Burstein and D.N.Langenberg.
J. appl. Phys. (USA), Suppl. to Vol. 32, No. 10, 2174-8 (Oct., 19 "Semiconducting Compounds" Conference Paper, Schenect 1961 (see Abstr. 14428 of 1961). A study of the de Haas–van A oscillations in the magnetic susceptibility was carried out in p- PbTe and n-type PbS. Measurements were made on oriented single crystal samples with carrier concentrations of the order 10^{18} cm^{-3} in pulsed magnetic fields up to 125 kG. The results f p-type PbTe indicate that the valence bands have a maximum a $\vec{k} = 0$, and four equivalent maxima at the {111} Brillouin zone fa The ⟨111⟩ ellipsoids have a longitudinal mass to transverse ma ratio of 6.4 ± 0.3. From the temperature dependence of the amplitude of the oscillations a value of 0.043 ± 0.006 m_0 has be obtained for the transverse effective mass. The data indicate t the (000) maximum and the (111) maxima lie within 0.002 ± 0.0 of each other. The data also indicate an effective broadeni temperature of about 8°K which is attributed to inhomogeneities in the carrier concentrations in the samples investig Preliminary results on n-type PbS show a single isotropic Fer surface cross-section with a cyclotron mass of 0.14 ± 0.04 m_0. direct and indirect optical interband transitions are discussed light of these results.

DE HAAS–VAN ALPHEN EFFECT IN p-TYPE PbTe AND n-TYPE PbS. See Abstr.

17931 DE HAAS–VAN ALPHEN EFFECT IN RHENIUM, NIOBIUM AND TANTALUM.
A.C.Thorsen and T.G.Berlincourt.
Phys. Rev. Letters (USA), Vol. 7, No. 6, 244-6 (Sept. 15, 1961).

Single crystal specimens, having room-temperature to liqu helium-temperature resistivity ratios of 540, 56 and ~ 600 for Nb and Ta respectively, were used. Four oscillating susceptib terms were found in Re with the field approximately parallel to [10$\bar{1}$0] direction, two in Nb with the field in the [110] direction two in Ta with the field 12° from [110] in (001) plane. The shor period term in Ta is very sensitive to orientation. The periods Fermi surface extremal cross-section and effective masses are tabulated. F.E.

17932 ON THE THEORY OF SPIN PARAMAGNETISM. L.Goldstein.
Ann. Phys. (USA), Vol. 15, No. 2, 141-56 (Aug., 1961).

Derives the expression of the partial entropy of spin orien tion in the spin system associated with a collection of bound at subject to the Pauli principle, whose mutual interactions depen quely on their space coordinates and whose Hamilton function i dependent of the spin coordinates of the atoms. These restrict on the Hamilton function of the system are the same as those w yield the quantum mechanical foundation of the molecular field description of spin ferromagnetism and paramagnetism in mets The absence of the spin coordinates from the Hamiltonian insu the behaviour of the spin system as if it were free. The enume tion of the various spin configurations or spin states, which de mine the orientational spin disorder, proceeds as in a system free spins, subject though to an internal field tending to resist thermal spin disorder in this non-ideal paramagnetic system through a reduction of its total spin angular momentum. The r obtained confirm those given previously on the basis of the ma ization process of a class of non-ideal paramagnetic systems s ject to the postulated existence of a molecular field.

17933 THE MAGNETIC SUSCEPTIBILITY OF Ag–Mn AN Cu–Mn SOLID SOLUTIONS BETWEEN 1.2°K AND 368°K. A.van Itterbeek, W.Peelaers and F.Steffens.
Appl. sci. Res. B(Netherlands), Vol. 8, No. 4, 337-48 (1960).

The magnetic susceptibility of Ag–Mn and Cu–Mn solid solutions containing between 0.25 and 5.3 at % Mn was measure between 1.2 and 368°K. The alloys obey a Curie–Weiss law up and including liquid nitrogen temperatures; p_{eff}, effective mag number, values derived for the manganese atom are discussed compared with other published values. At liquid hydrogen tem tures the alloys no longer obey a Curie–Weiss law. It was fou that some of the alloys show a transition from a paramagnetic an antiferromagnetic state. This occurs at the Néel temperatu T_N. The field dependence of the susceptibility was also invest ted. No field dependence occurs as long as the temperature at

measurements are done, is far above the Néel temperature Once in the neighbourhood of T_N, field dependence is observed.

34 PARAMAGNETISM OF TETRAPHENANTHROLINE DIHYDROXYL DIFERRIC CHLORIDE. N.Elliott.
m. Phys. (USA), Vol. 35, No. 4, 1273-4 (Oct., 1961).
he magnetic susceptibility of this compound (ferric nanthroline) was measured and found to show abnormal erature dependence. The results are explained in terms of ilibrium between a singlet ground state and an excited t state of the dimer.

935 MAGNETIC SUSCEPTIBILITIES OF Cr AND Cr—Fe ALLOY. M.Shimizu and T.Takahashi.
ys. Soc. Japan, Vol. 16, No. 8, 1544-8 (Aug., 1961).
he magnetic susceptibilities of Cr and Cr—Fe are investigated e use of the band picture for 3d electrons. The temperature ase of the magnetic susceptibility of Cr is attributed to a mini- of the electron state density. For the shape of the band of Cr odels are adopted, and the calculated susceptibilities are com- with the observed ones. According to this comparison, the of the band of Cr is discussed, and the result on its shape is ared with that calculated from the specific heat measurement temperatures by Cheng et al.(Abstr. 17896 of 1960).

36 THE MAGNETISM OF TOURMALINE.
V.M.Vinokurov and M.M.Zaripov.
allografiya (USSR), Vol. 4, No. 6, 873-7 (Nov.-Dec., 1959).
ssian.
onsidered in relation to the chemical composition and colour. auses of the various colours are discussed. [English transla- n: Soviet Physics—Crystallography (USA), Vol. 4, No. 6, 1 (June, 1960)].

37 A METHOD OF MEASURING PRINCIPAL MAGNETIC SUSCEPTIBILITIES OF TRICLINIC CRYSTALS.
lathur.
Nat. Inst. Sci. India A, Vol. 26, No. 6, 581-90 (Nov. 26, 1960).
new method was worked out for measuring principal etic susceptibilities of triclinic crystals having an axis of ximate magnetic symmetry. The susceptibility tensor was ormed from an arbitrary set of rectangular axes to principal etic axes. The method was verified by measuring principal etic susceptibilities of $CuSO_4.5H_2O$ and $CuSeO_4.5H_2O$ crystals mparing the results with those of previous workers.

38 PROCEEDINGS OF THE FERROMAGNETISM WORKING PARTY 1959 [BERICHTE DER ARBEITSGEMEINSCHAFT OMAGNETISMUS 1959].
ldorf: Verlag Stahleisen (1959) 270 pp. In German.
or abstracts of the papers presented at the above Conference, ostr. 1208, 1229, 1235-6, 2470-1, 2474-5, 2483, 3822, 3887, 1, 3900, 3904, 3910, 6271, 6276, 6884, 6297, 6338-40, 8368, 10169, 12536, 13151, 14700, 14740, 16482 of 1961.

939 THE $1/H^2$ TERM IN THE LAW OF APPROACH TO SATURATION AS A FUNCTION OF MAGNETO-STALLINE ENERGY FOR SEVERAL TYPES OF POLY-STALLINE FERROMAGNETICS. H.Danan and R.Barbier.
ys. Radium (France), Vol. 21, No. 12, 822-4 (Dec., 1960).
ench.
sing the general expression for the ferromagnetic magneto- lline energy, one calculates the coefficient of the $1/H^2$ term, ssing the rotation contribution, in the law of approach to satura- a polycrystalline ferromagnetic material. The following llographic symmetries have been especially considered: hombic, tetragonal, hexagonal and cubic.

40 GENERAL THEORY OF SUPEREXCHANGE INTERACTION. I. M.Fukuchi.
. theor. Phys. (Japan), Vol. 25, No. 6, 939-55 (June, 1961).
echanisms of superexchange interaction in a magnetic com- are investigated by using the second quantization method was originally developed by Bogolyubov in the polarized-ion for metals. The electron—field operator is expanded by a set of gonalized atomic orbitals which are constructed from the original rthogonal ones. By taking into account the configuration interaction the energy of the crystal is evaluated up to the fourth order of the overlap integral between the nearest neighbour orbitals. The coupling between spin pairs, which is obtained in the order of ϵ^4, is shown to be describable by the familiar spin-operator formalism. The effective interaction constant J has really a very complicated structure owing to non-orthogonality of the original orbitals. J contains the interaction in $\pi/2$-direction besides the usual interaction in π-direction.

17941 GENERAL THEORY OF SUPEREXCHANGE INTERACTION. II. M.Fukuchi.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 956-63 (June, 1961).
The method developed in the previous abstract is extended to include the excited-state orbitals, and new contributions to the spin-dependent energy is obtained.

17942 ON THE GREEN FUNCTION OF THE SPIN SYSTEM: I. K.Kawasaki and H.Mori.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1043-5 (June, 1961).
The spatial correlation functions of spins in a ferromagnetic medium are calculated approximately. Certain unexpected behaviour is discovered which requires further investigation. See also following abstract. R.A.Waldron

17943 ON THE GREEN FUNCTION OF THE SPIN SYSTEM. II. K.Kawasaki and H.Mori.
Progr. theor. Phys. (Japan), Vol. 25, No. 6, 1045-7 (June, 1961).
The method of Pt I (preceding abstract) is extended to cover cases where the spin is not equal to one-half. R.A.Waldron

17944 MAGNETIC PROPERTIES OF Co^{2+} IONS IN OCTAHEDRAL INTERSTICES OF AN OXIDE LATTICE. P.Cossee.
Molecular Phys. (GB), Vol. 3, No. 2, 125-9 (March, 1960).
The magnetic properties of Co^{2+} ions in octahedral environment are discussed in relation to the energy-level scheme. It appears that the three low-lying levels arising from the $^4F(\Gamma_4)$ triplet as a consequence of spin-orbit coupling are responsible for a temperature-dependent magnetic moment. The expected departure from the Curie—Weiss law is demonstrated by susceptibility measurements on mixed-crystals of CoO and MgO between 300^0 and 1200^0K. From the experimental data the spin-orbit coupling constant for Co^{2+} in these compounds is estimated to be $-136\ cm^{-1}$.

17945 HYPERFINE STRUCTURE OF DIVALENT AND TRIVALENT Fe^{57} IN COBALT OXIDE. G.K.Wertheim.
Phys. Rev. (USA), Vol. 124, No. 3, 764-7 (Nov. 1, 1961).
The hyperfine structure of divalent and trivalent iron in CoO was obtained from the Mössbauer effect of Fe^{57} produced by the electron-capture decay of Co^{57}. The two valence states were obtained respectively by X-ray and Auger effect de-excitation of the K-shell hole resulting from electron capture in divalent Co^{57}. Higher valence states which could be produced by multiple Auger de-excitation were not observed, indicating that their lifetimes are short. The magnetic field at a divalent iron nucleus at low temperature is 2.0×10^6 Oe and that at a trivalent one is 5.6×10^6 Oe. The quadrupole coupling in this almost cubic environment is less than 1.0 Mc/s.

17946 APPLICATION OF THE PADÉ APPROXIMANT METHOD TO THE INVESTIGATION OF SOME MAGNETIC PROPERTIES OF THE ISING MODEL. G.A.Baker, Jr.
Phys. Rev. (USA), Vol. 124, No. 3, 768-74 (Nov. 1, 1961).
On the basis of the Pade approximant method the author deduces from the exact series expansions for the Ising model that the reduced magnetic susceptibility behaves at the critical point

$$\chi_{fcc} \cong [0.09923/(0.101767 - w)]^{9/4},$$

$$\chi_{bcc} \cong [0.152773/(0.1561789 - w)]^{9/4},$$

$$\chi_{sc} \cong [0.22138/(0.218156 - w)]^{9/4},$$

$$\chi_t \cong [0.2432/(2 - \sqrt{3} - w)]^{7/4},$$

$$\chi_{sq} \cong [0.35724/(\sqrt{2} - 1 - w)]^{7/4},$$

and $$\chi_h \cong [0.4506/(1/\sqrt{3} - w)]^{7/4},$$

where $w = \tanh(J/kT)$ and the last figure quoted is somewhat uncer-

tain. The spontaneous magnetization is found to behave as

$$(I_0/I_\infty)_{fcc} \cong [12.5(0.664658 - z^2)]^{0.3},$$

$$(I_0/I_\infty)_{bcc} \cong [10.4(0.5326607 - z^2)]^{0.3},$$

$$(I_0/I_\infty)_{sc} \cong [10.9(0.411940 - z^2)]^{0.3},$$

where $z = \exp(-2J/kT)$ and again the last place quoted is somewhat uncertain. The numbers 5/4 and 7/4 have an error of at most 10^{-3}, and 0.3 of at most 10^{-2}. The lattices referred to are f.c.c., face-centred cubic; b.c.c., body-centred cubic; s.c., simple cubic; t, triangular; s.q., simple quadratic; and h, honeycomb.

17947 FERROMAGNETIC INTERACTION IN EuO.
B.T.Matthias, R.M.Bozorth and J.H.Van Vleck.
Phys. Rev. Letters (USA), Vol. 7, No. 5, 160-1 (Sept. 1, 1961).

EuO was found to be ferromagnetic with a Curie point at 77°K and a moment of 7 Bohr magnetous per atom. This is the clearest example of exchange interaction in a solid between atomic orbitals which are the same as in the free atom. The mechanism of the interaction is not discussed. D.J.Oliver

17948 NÉEL TEMPERATURES AND THERMOREMANENT MAGNETIZATIONS OF THE ALLOYS Mn_xPd_{100-x} ($34 \leq x \leq 42$). R.Wendling.
C.R. Acad. Sci. (France), Vol. 252, No. 21, 3207-9 (May 24, 1961).
In French.

The susceptibility of alloys produced at 1200°C has a cusp maximum at a temperature T_N. The magnitude of T_N decreases linearly as the manganese concentration decreases. After annealing at 450°C, the thermoremanent magnetization was found to be very weak. K.N.R.Taylor

17949 INTERNAL MAGNETIC FIELD IN IRON AND IRON ALLOYS MEASURED BY N.M.R.
Y.Kôi, A.Tsujimura, T.Hihara and T.Kushida.
J. Phys. Soc. Japan, Vol. 16, No. 5, 1040 (May, 1961).

The resonance frequencies of Co^{59} in (Fe + 1% Co) alloy and of Fe^{57} in pure iron were determined as functions of the temperature. The extrapolated 0°K frequency for the cobalt alloy corresponds to an internal field, H_i of 289.7 kOe which is smaller by about 30 kOe than that obtained by the (less accurate) measurement of specific heats. The H_i of the cobalt nuclei in the alloy is larger than in pure cobalt metal by 60-70 kOe. The resonance frequency of Co^{59} in iron drops off more rapidly than Fe^{57} in pure iron with increasing temperature. The line shape of Fe^{57} resonance is strongly affected by alloying and preliminary results for alloying with Ni and Cr are presented. F.E.Hoare

17950 EXPERIMENTAL TEST OF THE SPIN-WAVE THEORY OF A FERROMAGNET.
A.C.Gossard, V.Jaccarino and J.P.Remeika.
Phys. Rev. Letters (USA), Vol. 7, No. 4, 122-4 (Aug. 15, 1961).

The properties of the ferromagnet $CrBr_3$, recently discovered by Tsubokawa (Abstr. 12521 of 1961), closely approximate to the model used by Bloch (Abstr. 2578 of 1932) in his detailed theory of a ferromagnet. Using nuclear magnetic resonance techniques, precise measurements of the temperature dependence of the magnetization for this material were made. S.A.Ahern

17951 THE ADDITIONAL MAGNETIC ANISOTROPY INDUCED BY MAGNETIC ANNEAL IN FERROMAGNETIC FACE-CENTERED CUBIC SOLID SOLUTIONS. I. DEPENDENCE OF THE INDUCED MAGNETIC ANISOTROPY ON THE TEMPERATURE AND DURATION OF MAGNETIC ANNEAL, ON THE MEASURING TEMPERATURE, AND ON THE ALLOY COMPOSITION IN FACE-CENTERED CUBIC NICKEL–COBALT ALLOYS. M.Yamamoto, S.Taniguchi and K.Aoyagi.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 13, No. 3, 117-36 (June, 1961).

17952 THE ADDITIONAL MAGNETIC ANISOTROPY INDUCED BY MAGNETIC ANNEAL IN FERROMAGNETIC FACE-CENTERED CUBIC SOLID SOLUTIONS. II. CRYSTAL ORIENTATION DEPENDENCE OF THE INDUCED MAGNETIC ANISOTROPY IN FACE-CENTERED CUBIC NICKEL–COBALT AND NICKEL–IRON ALLOYS. K.Aoyagi.
Sci. Rep. Res. Insts Tohoko Univ. A (Japan), Vol. 13, No. 3, 137-50 (June, 1961).

17953 MAGNETIZATION CURVE OF AN INFINITE CYLIND
M.W.Muller and A.Wehlau.
J. appl. Phys. (USA), Vol. 32, No. 11, 2448-50 (Nov., 1961).

Calculated for an infinite ferromagnetic cylinder with negati uniaxial anisotropy. The cylinder axis is a hard magnetocrystall direction and the basal plane is an easy plane. The applied field lies along the cylinder axis. The distribution of the magnetizatio corresponds to the azimuthally symmetric mode denoted as "magnetization curling". With this choice of anisotropy, stable solutions for the distribution can be obtained through partial reversal of the magnetization.

17954 REMANENT STRUCTURE ON MAGNETOPLUMBITE
J.Kaczér and R.Gemperle.
Czech. J. Phys., Vol. 10, No. 8, 614 (1960).

When thin films of single-crystal magnetoplumbite are demagnetized to the remanent state, the resultant domain structu depends on the direction of the external magnetic field. M.A.Ta

17955 ON THE RECTANGULARITY OF THE HYSTERESIS LOOP OF SOLID SOLUTIONS BELONGING TO THE SYSTEM $Mn_{1+x}Fe_{2-x}O_4$, $-0.1 < x < +0.14$. A.Bragiński.
Czech. J. Phys., Vol. 11, No. 1, 66-9 (1961).

The shape of the hysteresis loop depends on the magneto-crystalline anisotropy, but other components of crystalline ener must also be taken into account. Goodenough introduced a theor according to which a reduction in loop squareness occurs by nucleation of magnetisation in the reverse direction. The relati between loop squareness and nucleation field is studied experimentally, and it is concluded that Goodenough's model correspo to a certain extent to physical reality. R.A.Wal

17956 SPONTANEOUS MAGNETIZATION OF MAGNESIUM FERRITE–MANGANITE SYSTEM.
K.Muramori and S.Miyahara.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2354 (Dec., 1960).

Powder specimens with the formula $MgFe_{2-a}Mn_aO_4$ ("a" fro 0.0 to 2.0) were studied. For specimens with a = 0.0 to about 1. the observed magnetic moments are in good agreement with the values expected on Néel's theory. Magnetic moments for specim with $a > 1.0$ are much smaller than expected. D.S.Para

17957 ON THE MECHANISM OF REVERSIBLE APPEARAN OF RESIDUAL MAGNETIZATION AT LOW TEMPER TURE TRANSITIONS IN αFe_2O_3.
K.Siratori, A.Tasaki and S.Iida.
J. Phys. Soc. Japan, Vol. 15, No. 12, 2357-7 (Dec., 1960).

The weak residual magnetization of αFe_2O_3 which has once disappeared in passing through the transition point from high temperature, appears again in the same direction when the temp ture is raised. An explanation is suggested based on the followi expression for the magnetic anisotropy:

$$E = K_U \cos^2\theta + K_1' \cos\theta \sin^3\theta \sin 3\phi - K_U' \sin^2\theta \sin^2\phi,$$

$K_U > 0$ when $T > T_C$. D.S.Para

17958 BLOCH WALL EXCITATION. APPLICATION TO NUCLEAR RESONANCE IN A BLOCH WALL.
J.M.Winter.
Phys. Rev. (USA), Vol. 124, No. 2, 452-9 (Oct. 15, 1961).

The excitation spectrum of an assembly of electronic spins a Bloch wall structure is studied, assuming a uniaxial anisotrop The spectrum may be divided into two branches: one is a specif wall excitation and does not spread outside the wall, the other on is similar to the spin-wave excitation spectrum in a uniform fer magnet. These calculations are used to study the properties of the nuclear magnetic resonances in a Bloch wall. The relaxatio times are evaluated, taking into account the damping of the motio of the electronic spins and are compared with experimental valu The spin–spin coupling and the variation of the magnetization across the wall is also estimated.

NUCLEAR RESONANCE IN A BLOCH WALL.
See Abstr.

59 TRANSMISSION FACTOR OF A BLOCH WALL FOR SPIN WAVES WITH A WAVE VECTOR NORMAL TO THE)ARY. F.Bourton.
cad. Sci. (France), Vol. 252, No. 25, 3955-7 (June 19, 1961).
ich.
calculation on the propagation of low-energy spin waves in a agnetic with a magneto-crystalline energy term of the type shows that the Bloch walls are completely transparent to the For low energies this result is independent of the actual of the incident waves. R.Parker

60 PECULIARITIES IN THE DETECTION OF DOMAIN STRUCTURE OF FERROMAGNETIC CRYSTALS BY RENT METHODS. V.D.Dylgerov and I.F.Degtyarev.
llografiya (USSR), Vol. 5, No. 5, 809-11 (Sept.-Oct., 1960).
sian.
agneto-optical studies on single crystals of transformer reveal additional boundaries to those found by the powder d. The latter however permits greater magnification in raphy and the two methods are considered to be supple-ry. [English translation in: Soviet Physics—Crystallography Vol. 5, No. 5, 770-2 (March-April, 1961)]. J.H.Mason

61 MAGNETIC ANISOTROPY IN THIN FERROMAGNETIC FILMS. A.Corciovei.
J. Phys., Vol. 10, No. 12, 917-26 (1960).
e magnetic properties of thin ferromagnetic films are taking into account the magnetic anisotropy term in the onian. In the second approximation equations are obtained magnetization of the monatomic layers parallel to the surface hin film. From these equations one obtains the Curie tem-re, which depends on the thickness of the thin film and the between the ansiotropy constant and the exchange energy n two neighbours. A value can be chosen for α such that the m becomes ferromagnetic only for a thickness greater than a e value, and in this manner the theoretical results can be o the experimental data. The situation in cobalt thin films is ith in particular.

62 LOCAL VARIATIONS OF UNIAXIAL ANISOTROPY IN THIN FILMS.
t, V.Kamberský, Z.Málek and M.Ondris.
J. Phys., Vol. 10, No. 8, 616-17 (1960).
e variation of uniaxial anisotropy across vacuum deposited lloy films was measured by ferromagnetic resonance.
M.A.Taylor

63 ANISOTROPY OF POLYCRYSTALLINE SHEETS OF V-PERMENDUR. C.Kuroda.
. Soc. Japan, Vol. 15, No. 12, 2355 (Dec., 1960).
ecimens containing 49.5% Fe, 48.9% Co and 1.6% V by weight tudied. Torque curves were obtained from 200 Oe to 440 Oe m 500 Oe to 9500 Oe. The directions of magnetization are nd 135° to the rolling direction of the specimens and the 4-9 s predominant. The torque amplitude has a maximum value t 500 Oe. Several possible mechanisms for this behaviour sidered and rejected. It is concluded that the torque decrease ably caused by lattice defects not completely annihilated on tallization at 850° C and forming some ordered structure.
D.S.Parasnis

64 MAGNETISM OF THE IRON PARTICLES AS REVEALED BY ELECTRON DIFFRACTION. S.Yamaguchi.
J. Phys., Vol. 34, No. 11, 535-7 (Nov., 1960).
e saturation magnetic induction of iron particles is estimated e eccentricity of electron diffraction patterns which arises e deviations due to the Lorentz force. By comparing the ion rings obtained with fast electrons (which penetrate to the material) with those for slow electrons (represent-surface layers) a fraction of 0.92 is estimated for the surface-to-bulk induction. This is ascribed to an oxide
R.Parker

65 CHANGE OF LENGTH IN A MAGNETIC FIELD OF FERROMAGNETIC DISPERSIONS. G.Vogler.
hys. (Germany), Vol. 7, No. 7-8, 387-96 (1961). In German.
continuation of earlier work (Abstr. 9027 of 1961; see also 13440 of 1959). The magnetostrictive changes of length of yl iron particles dispersed with varying degrees of packing in rubber cylinders are ascribed to particle interactions, in good agreement with the measured changes. E.P.Wohlfarth

17966 THE INTERNAL FRICTION OF LONGITUDINAL OSCILLATIONS IN FERROMAGNETIC MATERIALS. L.Špaček.
Czech. J. Phys., Vol. 10, No. 6, 439-51 (1960).
The paper deals with the theory of the new magnetomechanical phenomenon in an alternating field. The first part concerns the internal friction of longitudinal oscillations of a ferromagnetic material in the shape of a wire in a constant magnetic field. It is assumed that the medium in which the sample oscillates is conducting and has a certain permeability. Equations defining the magnetic field in the oscillating material are derived from the basic thermodynamic relations. The term describing the non-conservative force component in a complex formulation is used to determine the internal friction. A general relation between the internal friction and the magnetic field is derived, as well as other expressions, which are a simplification of it. The second part of the paper deals with internal friction in an alternating field. It is shown that the solution can be transformed to the sum of the internal frictions of the different harmonic oscillations, which are obtained as a partial solution of the problem on the assumption that the elastic oscillations in interaction with the field oscillations are separated into their harmonic components. The calculation then becomes that of the internal friction considered in the first part of the paper. In this case the internal friction significantly depends on the field amplitude. The functional dependence of the internal friction peak on the frequency of the mechanical oscillations is also calculated. The agreement of the theory with experiment is satisfactory.

17967 THE INTERNAL FRICTION OF TORSIONAL OSCILLATIONS IN FERROMAGNETIC MATERIALS. L.Špaček.
Czech. J. Phys., Vol. 10, No. 12, 902-16 (1960).
Continues earlier work (see preceding abstract) and deals with the internal friction of torsional oscillations of ferromagnetic materials in a static and an alternating magnetic field. The calculation differs considerably from the case of longitudinal oscillations, particularly in the following points. In the first place, the internal friction of torsional oscillations depends quite differently on the dimensions of the sample, and the continuous distribution of magnetic domains and Bloch walls cannot be so easily defined. Secondly, a magnetic field created as a result of eddy currents during torsional oscillations does not penetrate the surroundings, so that the internal friction in an electrically conducting medium is the same as in vacuum. Thirdly, the deformation here is an antisymmetrical function of the field, so that the coefficient η' is an even function while with longitudinal oscillations it was expressed by an odd function. Despite these different conditions the results are very similar to those with longitudinal oscillations and agree well with experiment. In an alternating magnetic field the internal friction of torsional oscillations has a sharp maximum at $H = 0.64H_S$ where H_S is the saturated value of the field for which magnetoelastic effects disappear.

17968 THE EFFECT OF SIXTH DEGREE CUBIC FIELD ON RARE-EARTH IONS IN CRYSTALS.
A.Mookherji and D.Neogy.
Current Sci. (India), Vol. 30, No. 6, 217-18 (June, 1961).
The magnetic anisotropy and principal magnetic moments of single crystals of $Er_2(SO_4)_3 8H_2O$ were measured between 80° and 300° K. The anisotropy is at least 0.10 for $Er_2(SO_4)_3 8H_2O$ and 0.11 for the isomorphous $Nd_2(SO_4)_3 8H_2O$. For the rare earth ionic salts measurements of the mean principal moment determines the cubic part of the crystalline field and the non cubic term can be derived from the anisotropy. A single fourth degree cubic field was found sufficient to represent the mean moment of $Er_2(SO_4)_3 8H_2O$ at all temperatures within the studied range. Field terms of sixth degree must be included for an exact calculation of the mean magnetic moment, however. P.J.Dean

17969 THE MAGNETOELASTIC CONSTANTS OF NICKEL. E.W.Lee and R.R.Birss.
Proc. Phys. Soc. (GB), Vol. 78, Pt 3, 391-8 (Sept., 1961).
The magnetoelastic constants are calculated from the magnetostriction constant measured by Birss and Lee (Abstr. 1225 of 1961) and elastic constants measured by Alers, Neighbours and Sato (Abstr. 11874 of 1960). It is shown that the temperature variation of these magnetoelastic constants is in good agreement with the theory proposed by Kittel and Van Vleck (Abstr. 10162 of 1960). According to this theory the magnetoelastic constants depend upon

the magnitude of the spontaneous magnetization. This may be increased slightly by a large magnetic field and it is shown that the theory explains, in principle, the origin of the forced magnetostriction.

THE MAGNETOELASTIC CONSTANTS OF NICKEL.
See Abstr.

17970 FERROMAGNETIC RELAXATION. II. THE ROLE OF FOUR-MAGNON PROCESSES IN RELAXING THE MAGNETIZATION IN FERROMAGNETIC INSULATORS.
P.Pincus, M.Sparks and R.C.LeCraw.
Phys. Rev. (USA), Vol. 124, No. 4, 1015-18 (Nov. 15, 1961).

For Pt I, see Abstr. 7761 of 1961. The role of four-magnon processes in relaxing the uniform precession, in relaxing magnons of non-zero wave vector in parallel pumping experiments, and in establishing thermal equilibrium is considered. It is shown that the effect of the exchange-induced four-magnon process should be observable in parallel pumping experiments, but it is found that the four-magnon processes arising from dipole, cubic anisotropy, and exchange coupling are not very effective in relaxing the uniform precession. Both three- and four-magnon processes are important in the later stages of the relaxation scheme by which thermal equilibrium is established.

17971 EFFECT OF SPIN–SPIN AND SPIN–PHONON INTERACTIONS IN A FERROMAGNETIC ON THE ENERGY DISTRIBUTION OF SCATTERED NEUTRONS.
V.N.Kashcheev and M.A.Krivoglaz.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 5, 1541-52 (May, 1961).
In Russian.

For abstract, see Abstr. 14731 of 1961. [English translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 5, 1117-26 (Nov., 1961)].

17972 OPTICAL OBSERVATION OF FERRIMAGNETIC DOMAINS. M.A.Jeppersen and W.A.Sloan.
Amer. J. Phys., Vol. 29, No. 11, 789 (Nov., 1961).

The Faraday rotation in transparent ferrimagnetic garnet disks may be used not only to demonstrate the magnetic domain distribution but also to plot the magnetization curve of the specimen. This is done by placing the specimen on a polarizing microscope, replacing the eyepiece by a photomultiplier, and measuring the output current of the latter as a function of field applied to the specimen. The photomultiplier is calibrated in terms of the known saturation magnetization of the specimen. A complete hysteresis loop was plotted by this method for a gadolinium iron garnet crystal.

R.Parker

17973 SOME EXPERIMENTAL RESULTS CONCERNING RELAXATION PHENOMENA IN Ni–Zn FERRITES.
A.Marais and T.Merceron.
C.R. Acad. Sci. (France), Vol. 252, No. 23, 3553-5 (June 5, 1961).
In French.

There are two relaxation effects, one at room temperature, the other at a higher temperature. The disaccommodation was measured as a function of temperature for samples prepared under vario firing conditions. The results obtained are discussed in relati the departure from stoichiometry of the samples. R.A.Wa

17974 SOME EXPERIMENTAL RESULTS ON THE PHENO MENON OF RELAXATION IN Mn–Zn FERRITES.
A.Braginski, A.Marais and T.Merceron.
C.R. Acad. Sci. (France), Vol. 253, No. 2, 239-41 (July 10, 1961
In French.

Iron rich Mn–Zn ferrites show three relaxation regions between liquid nitrogen temperature and the Curie temperature It is shown that two of these regions, those occurring below roo temperature, are due to ionic diffusion via vacancies; and that t third is due to electron exchange $Fe^{2+} \rightleftharpoons Fe^{3+}$. S.A.A

17975 THE RELATION BETWEEN THE INNER DEMAGNETIZING FACTOR OF MANGANESE MAGNESIUM FERRITES AND THEIR POROSITY AND PERMEABILITY. J.Brož and J.Šternberk.
Czech. J. Phys., Vol. 10, No. 9, 670-3 (1960).

It is shown that the simple relation of direct proportionali between the inner demagnetizing factor and the relative volume the pores is not sufficient to explain the experimental data obt on a system of manganese magnesium ferrites. An equation is derived in which the inner demagnetizing factor is directly proportional to the ratio of the relative volume of the pores to permeability of the sample. The values calculated according t equation agree well with the experimental results.

17976 MAGNETIC RELAXATION SPECTRUM OF FERRI $Mn_xFe_{3-x}O_{4+y}$. S.Krupička and F.Vílum.
Czech. J. Phys., Vol. 11, No. 1, 10-17 (1961).

The initial permeability disaccommodation in ferrites $Mn_xFe_{3-x}O_{4+y}$, $0.5 \leq x \leq 1$, was studied in a temperature rang around -200°C to $+180^{\circ}$C. Four separate bands were found in relaxation spectrum of these ferrites.

17977 DYNAMICS OF POWDER FIGURES IN MONO-CRYSTALLINE MAGNESIUM–MANGANESE FERR
A.I.Drokin, V.D.Dylgerov and Yu.M.Zolotareva.
Fiz. tverdogo Tela (USSR), Vol. 3, No. 2, 553-7 (Feb., 1961).
In Russian.

Powder figures are obtained on a 110 surface in a sample magnesium–manganese ferrite (0.5 Fe_2O_3, 0.4 MnO, 0.1 MgO) with spinel structure. The results show the figures at various parts of the magnetization cycle for applied fields in the 011 a 001 directions. It is observed that some of the boundaries are removed even in small fields. At field strengths near to the coercive force, sudden reversals of the magnetization vector occur, retaining the general form of the domain structure. [E translation in: Soviet Physics–Solid State (USA), Vol. 3, No. 2 405-8 (Aug., 1961)]. K.N.R.T

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Vol. 64 (1961). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Cybernetica	Cybernetica [Abstracted by Mathematical Reviews].
Internat. TV tech. Rev. (GB)	International TV Technical Review 31 St George Street, Hanover Square, London. W.1.
J. Inst. Navig. (GB)	Journal of the Institute of Navigation 1 Kensington Gore, London, S.W.7. Publication address: John Murray, 50 Albemarle Street, London, W.1.
J. Math. Kyoto Univ. (Japan)	Journal of Mathematics of Kyoto University (Formerly: Memoirs of the College of Science, University of Kyoto. Series A: Mathematics) Mathematical Institute, Faculty of Science, Kyoto University, Kyoto.
Technica (Switzerland)	Technica E.Birkhäuser, Elisabethenstrasse 19, Basle 10; Birkhäuser Verlag, Stuttgart S.
Z. angew. Math. Mech. (Germany)	Zeitschrift für angewandte Mathematik und Mechanik. Akademie-Verlag, Leipziger Strasse 3-4, Berlin, W.8.

CHANGE OF TITLE

Mem. Coll. Sci. Univ. Kyoto (Japan)	Memoirs of the College of Science, University of Kyoto Series A: Mathematics Title changed to: Journal of Mathematics of Kyoto University [J. Math. Kyoto Univ.] with issue dated Vol. 1, No. 1, Sept., 1961.

ERRATA

Reactor Science, Vol. 11, No. 2-4 (Feb., 1960); Vol. 12, No. 1-2 (May, 1960); Vol. 12, No. 3 (June, 1960): In some of the abstracts covering the above issues the journal reference has been given as "Reactor Sci. Technol." instead of "Reactor Sci.".

Abstr. 11891 (1961) line 20: for "phase difference T_0 and the oscillator" read "phase difference between T_0 and the oscillator".
Abstr. 11979 (1961) line 3: for "O.F.Nyemetz" read "O.F.Nyemets".
Abstr. 12201 (1961) line 2: for "I.A.Tot'skȳi" read "I.A.Tots'kȳi".
Abstr. 12222 (1961) table, under Carbon: for "86 ± 550" read "86 ± 55".
Abstr. 12234 (1961) line 17: for "sodium band" read "sodium bond".
Abstr. 12261 (1961) line 7: for "devised" read "derived".
Abstr. 12311 (1961) line 3: for "C.Berthet" read "G.Berthet".
Abstr. 12420 (1961) : for end of text see Abstr. 12426 (1961) lines 7 to end.
Abstr. 12426 (1961) : for line 7 of text to end see top of right-hand column, p. 1199.
Abstr. 12531 (1961) line 9: for "Fe—Fe lattice" read "FeTe lattice".
Abstr. 12823 (1961) line 3: for "Ya.V.Tsekhmistrenko" read "Yu.V.Tsekhmistrenko".
Abstr. 12879 (1961) line 2: for "O.Z.Golik" read "O.Z.Holik".
Abstr. 14121 (1961) line 2: for "I.S.Srivastava" read "I.B.Srivastava".
Abstr. 14622 (1961) line 3: for "V.S.Neshpov" read "V.S.Neshpor".
Abstr. 15204 (1961) line 4: for "Tsai-Chii" read "Tsai-Chü".
Author Index (Sept., 1961) : after "Marino,L.L.", Neynaber,R.H.", Rothe,E.W.", and "Trujillo,S.M.", for "10079" read "11079".
Author Index (Sept., 1961) : for "Tietz,T., 10087" read "Tietz,T., 11087".

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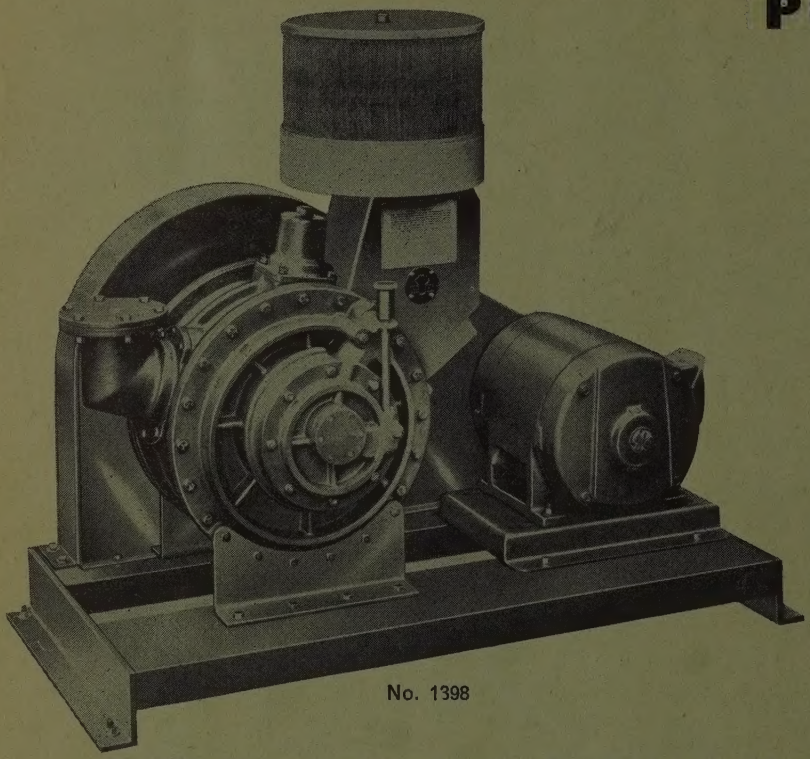

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